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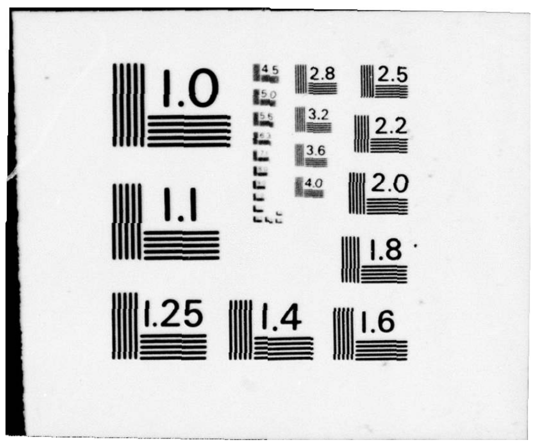
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REPORT SAMSO TR 76-92, VOLUME II

SECOND SURFACE THERMAL CONTROL MIRRORS FOR REFLECTION CONTROL

SPACE AND MISSILE SYSTEMS ORGANIZATION

GENERAL DYNAMICS CONVAIR DIVISION
SAN DIEGO, CA 92138

JANUARY 1977

FINAL TECHNICAL REPORT, VOLUME II

PREPARED FOR

DEPARTMENT OF THE AIR FORCE
HQ. SPACE AND MISSILE SYSTEMS ORGANIZATION (AFSC)/YAS
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This final report documents the results of a theoretical and experimental program to investigate ways to make second surface mirrors (e.g., thermal control surfaces, composed of thin transparent materials such as fused silica and FEP Teflon with a reflective backing, which are used on space vehicles) which are diffusely reflective but which retain the high solar reflectance of commercial specularly reflecting second surface mirrors. A number of designs were surveyed and four designs were fully evaluated. Three of these designs employed fused silica substrates with front or front and back surfaces ground with

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grinding compounds and then etched in a hydrogen fluoride solution. When suitably silvered on the back sides, these specimens met design goals. One of these designs employed a FEP Teflon substrate with front and back surfaces contoured by compression of Teflon sheet between quartz plates in a vacuum oven. When silvered on the back side, good diffuseness was obtained but solar reflectance was slightly degraded over the reflectance of commercial Teflon second surface mirrors.

SECOND SURFACE THERMAL CONTROL MIRRORS
FOR REFLECTION CONTROL
VOLUME II
FINAL TECHNICAL REPORT

1? JANUARY 1977

CONTRACT F04701-74-C-0318

GENERAL DYNAMICS
CONVAIR DIVISION

MICROMETERS

MICROMETERS

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MICROMETERS

MICROMETERS

ANNEX I

EXPERIMENTAL DIRECTIONAL-HEMISPHERICAL REFLECTANCE FROM 0.28 TO 2.5 μm AND CALCULATION OF SOLAR ABSORPTANCE

ANNEX I

EXPERIMENTAL DIRECTIONAL-HEMISPHERICAL REFLECTANCE FROM 0.28 to 2.5 μm AND CALCULATION OF SOLAR ABSORPTANCE

The directional-hemispherical reflectance, $\rho_S(\lambda)$, in the ultraviolet, visible, and near-infrared is required in this work for two purposes: (1) to determine the solar absorptance ($\alpha_S[\lambda] + \rho_S[\lambda] = 1$), and (2) to provide the total value of the reflected energy to put the bidirectional reflectances in absolute terms, as noted in Annex III.

The Cary Model 14 spectrophotometer with specially designed transfer optics and a Convair-designed and built integrating sphere was used for the directional reflectance measurements from 0.28 to 2.5μm. A schematic representation appears in Figure I-1.

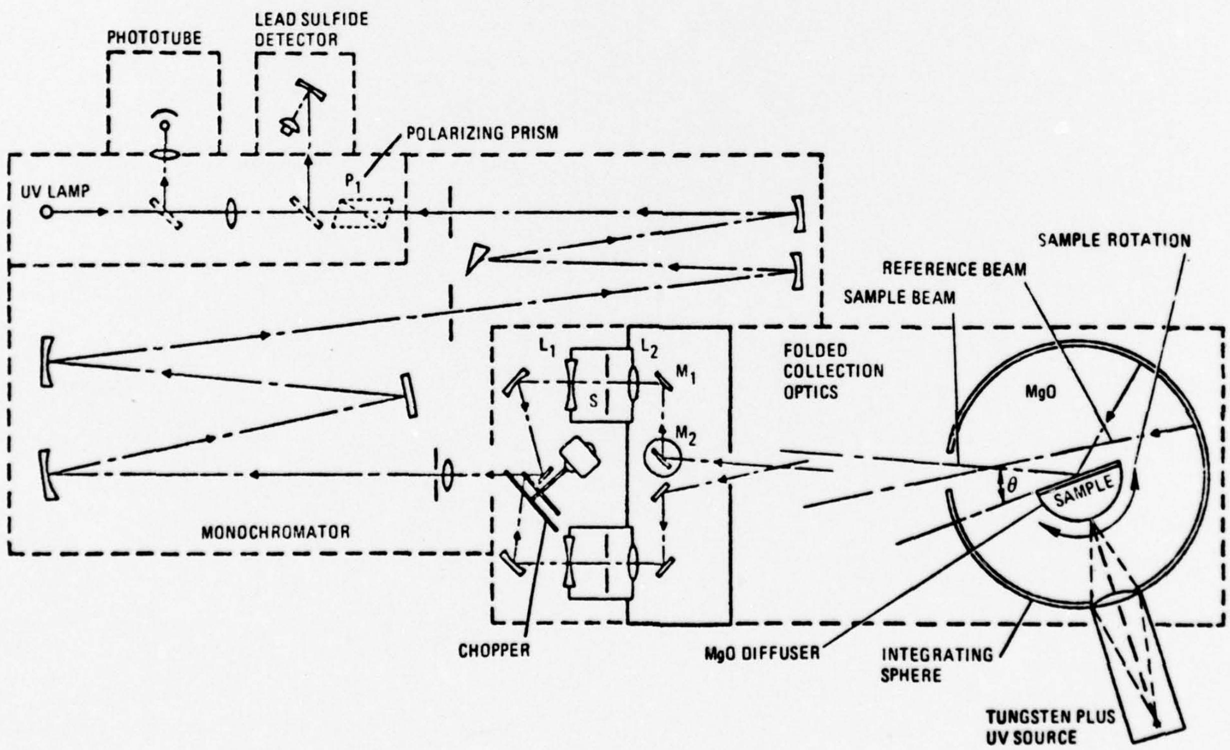

Figure I-1. Optical Schematic of Cary Model 14 and Integrating Sphere Attachment

The spectrometer is a double-beam instrument with automatic scan and readout that is linear in wavelength. The double monochromator contains a grating in series with a fused silica prism and the errors due to stray light are negligible. With the sphere attachment, scans between 0.28 to 2.5μm are possible.

The integrating sphere consists of a 9-in.-diameter sphere coated on the inside with a thick layer of MgO. The sample, located at the center, is uniformly irradiated by the MgO surface. This uniform irradiation is obtained by focusing the light from a 1,000-watt (3,400K) Sun Gun lamp, and a 250-watt Xenon lamp onto a curved MgO diffuser on the back of the sample. The diffuser scatters the light to the part of the sphere behind the sample which, in turn, scatters the light to the hemisphere seen by the sample. Thus, a uniformly irradiated hemisphere of 2π sr is created over the sample. One spectrometer beam originates from the sample (I), the other from the MgO wall (I_0). The ratio of these two beams is the directional-hemispherical reflectance of the sample and is displayed on the recorder as a function of wavelength.* The sample holder rotates to provide variations in angle θ.

Data are recorded on a stripchart recorder. This chart is read at closely spaced wavelength intervals (reflectance versus wavelength) and the digital data transferred to punched cards for computer processing. A computer routine processes the data to provide the solar reflectance based on the Air Mass Zero Solar Spectral Irradiance, as per ASTM E490-73. An example of a printout sheet is shown in Figure I-2.

This figure also includes emittance data, which is processed by computer, as described below. Reflectance data are also presented in graphical form.

The measurements of hemispherical-directional reflectance described below were used to compute the solar absorptance in the wavelength interval from 0.28 to 2.5 μm, using the Air Mass Zero Spectral Irradiance, as per ASTM E 490-73

The data will be digitized for computation of solar absorptance, using the following formula:

$$\alpha_s = \frac{\int_{0.28}^{2.5} (1 - \rho_\lambda)\, E_\lambda \, d\lambda}{\int_{0.28}^{2.5} E_\lambda \, d\lambda}$$

where ρ_λ = the measured directional reflectance

E_λ = the Air Mass Zero Solar Spectral Irradiance

*The hemispherical-directional reflectance is actually measured. The numerical val-value of this reflectance is identical to the desired directional-hemispherical emittance.

REFLECTIVITY DATA RADIANT ENERGY TRANSFER GROUP SPACE SCIENCE LABORATORIES GD-CONVAIR
RADIANT ENERGY TRANSFER GROUP SPACE SCIENCE LABORATORY GD-CONVAIR
AMPLE IDENT ZINC OXIDE POTASSIUM SILICATE WHITE PAINT GHB
DATE 7-19-71 REQUESTOR

WAVE LENGTH	REFLECT-ANCE	WAVE LENGTH	REFLECT-ANCE	WAVE LENGTH	REFLECT-ANCE	WAVE LENGTH	REFLECT-ANCE//
3.000E-01	3.300E-02	3.200E-01	3.300E-02	3.300E-01	3.300E-02	3.350E-01	3.300E-02
3.500E-01	3.400E-02	3.600E-01	3.700E-02	3.700E-01	4.500E-02	3.750E-01	5.800E-02
3.900E-01	6.180E-01	4.000E-01	6.930E-01	4.100E-01	7.450E-01	4.200E-01	7.720E-01
4.300E-01	7.850E-01	4.400E-01	7.950E-01	4.450E-01	8.000E-01	4.500E-01	8.040E-01
4.650E-01	8.130E-01	4.750E-01	8.150E-01	4.900E-01	8.220E-01	4.950E-01	8.240E-01
5.000E-01	8.240E-01	5.100E-01	8.260E-01	5.200E-01	8.290E-01	5.400E-01	8.300E-01
5.700E-01	8.340E-01	7.000E-01	8.380E-01	8.000E-01	8.390E-01	9.000E-01	8.360E-01
1.000E+00	8.330E-01	1.100E+00	8.300E-01	1.200E+00	8.260E-01	1.300E+00	8.180E-01
1.400E+00	7.950E-01	1.500E+00	7.830E-01	1.600E+00	7.700E-01	1.700E+00	7.450E-01
1.800E+00	7.150E-01	2.000E+00	6.390E-01	2.500E+00	3.830E-01	3.000E+00	1.300E-01
3.500E+00	5.800E-02	4.000E+00	5.500E-02	4.500E+00	6.900E-02	5.000E+00	3.900E-02
5.500E+00	2.700E-02	6.000E+00	2.000E-02	6.500E+00	2.300E-02	7.000E+00	2.000E-02
7.500E+00	2.300E-02	8.000E+00	1.500E-02	8.500E+00	1.000E-02	9.000E+00	1.200E-02
9.500E+00	1.300E-02	1.000E+01	1.700E-02	1.050E+01	1.700E-02	1.100E+01	1.500E-02
1.150E+01	1.400E-02	1.200E+01	1.100E-02	1.250E+01	1.000E-02	1.300E+01	1.000E-02
1.400E+01	1.000E-02	1.500E+01	1.200E-02	1.600E+01	1.000E-02	1.700E+01	1.000E-02
1.800E+01	3.600E-02	1.900E+01	5.300E-02	2.000E+01	6.500E-02	2.100E+01	7.300E-02
2.200E+01	9.400E-02	2.300E+01	1.130E-01	2.400E+01	1.390E-01	2.500E+01	1.390E-01
2.600E+01	1.390E-01	2.700E+01	1.390E-01	2.800E+01	1.390E-01	2.900E+01	1.390E-01
3.000E+01	1.390E-01	3.100E+01	1.390E-01	3.200E+01	1.390E-01	-0.	-0.

EMITTANCE REQUIRED 100 X 300 X 500 X SOLAR ABSORPTANCE X OTHER
200 X 400 X CARBON ARC ABSORPTANCE

EMITTANCE (100 K)=8.709036E-01 SUMMATION RATIO=2.937648E-01

EMITTANCE (300 K)=9.533718E-01 SUMMATION RATIO=8.683973E-01

EMITTANCE (500 K)=9.589184E-01 SUMMATION RATIO=9.168468E-01

SOLAR ABSORPTANCE =2.673257E-01 SUMMATION RATIO=2.673257E-01

EMITTANCE (200 K)=9.201147E-01 SUMMATION RATIO=6.983622E-01

EMITTANCE (400 K)=9.588170E-01 SUMMATION RATIO=8.877579E-01

Figure I-2. Samle Computer Printout Sheet

ANNEX II

EXPERIMENTAL DIRECTIONAL-HEMISPHERICAL REFLECTANCE FROM 2.0 to 30 μm AND CALCULATION OF THERMAL EMITTANCE

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EXPERIMENTAL DIRECTIONAL-HEMISPHERICAL REFLECTANCE FROM 2.0 to 30 μM AND CALCULATION OF THERMAL EMITTANCE

Reflectances of candidate samples were determined from 2.0 to 30 m using the Convair Division ellipsoidal reflectometer. Thus, solar reflectance data are provided between 0.28 and 30 μm. Directional thermal emittance as a function of wavelength ϵ_λ was derived from the directional-hemispherical* reflectance as a function of wavelength ρ_λ using the relationship:

$$\rho_\lambda + \epsilon_\lambda = 1$$

Data was processed by computer subroutine to provide thermal emittance at 300K (and other temperatures), see Figure I-2. Data presentation was both graphical and tabular.

The essential features of the optical system may be understood by referring to Figure II-1. The Pyrex ellispoid has a highly polished inner surface upon which a film of aluminum has been evaporated. It has a semi-major axis of 6 inches and a semi-minor axis of 5.916 inches, with foci 2 inches apart. The source is placed on the semi-major axis with its center at one focus; the sample is centered at the other focus, as shown in Figure II-1. The focusing characteristics of the ellipsoid are such that a point source of light emanating from one focus is imaged at the other. Using a properly sized radiation source, the sample is uniformly irradiated over a hemisphere of 2π sr.

The source system — including the source, ellipsoid, sample holder, and chopper — form an integral unit that is designated to rotate about an axis through the center of the sample, as shown in Figures II-1 and II-2. The light-gathering and transfer optics, consisting of a small overhead mirror (M1) and subsequent mirrors (M2, M3 and M4), are fixed and do not rotate. Mirrors M1 and M2 are held in position by a bracket that anchors into the central tee, to which the vacuum pump is attached. For making routine near-normal measurements, as required in this work, the ellipse rotation is set as shown in Figure II-1. The overhead mirror (M1) views the sample from 10 degrees off normal. To obtain the 100% datum (see Figure II-1), the sample is removed from its position at one of the foci and the ellipse is rotated so that the small overhead mirror (M1) receives the full radiation incident on the sample position (but with the sample removed), thus providing a system for true absolute measurements.

Measurements of directional-hemispherical reflectance* were made on two samples of each of the four selected designs, and repeated on two samples each of the best two designs. The measurements were made over the wavelength interval 2.0 to 30.0 μm. These

*The hemispherical directional reflectance is actually measured. The numerical value of this reflectance is identical to the directional-hemispherical reflectance used to compute the directional thermal emittance.

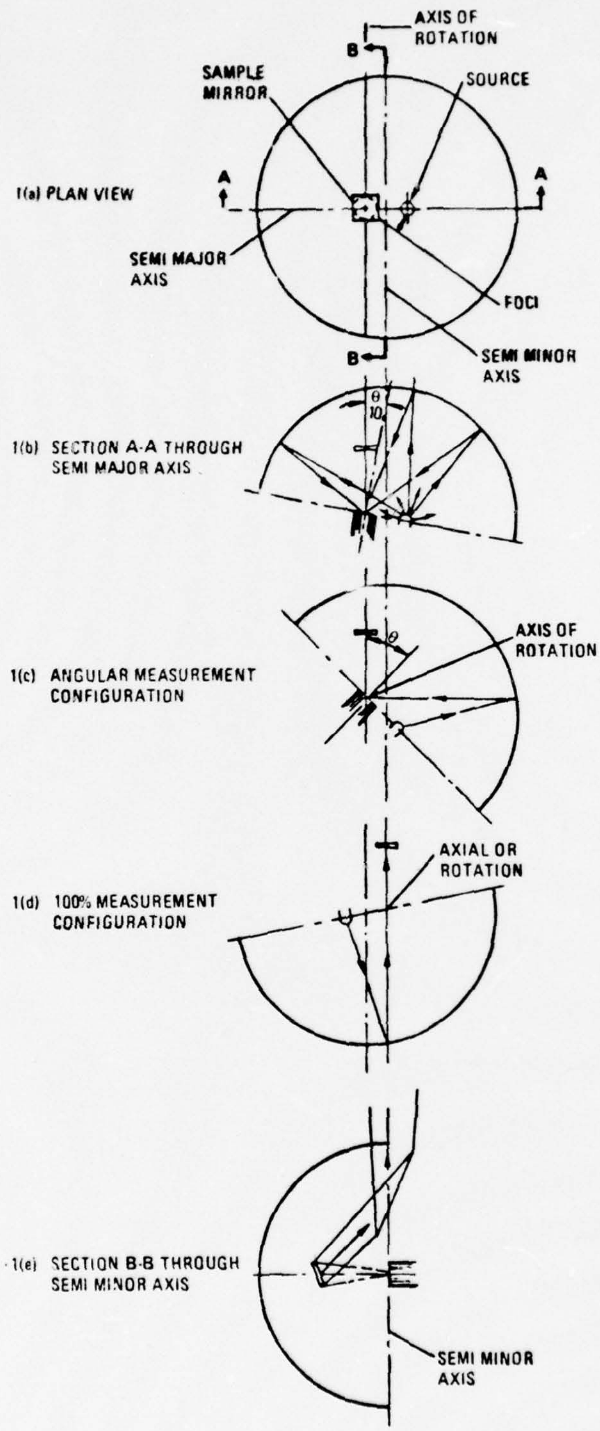

Figure II-1. Source, Sample, and Hemi-Ellipsoid Arrangement

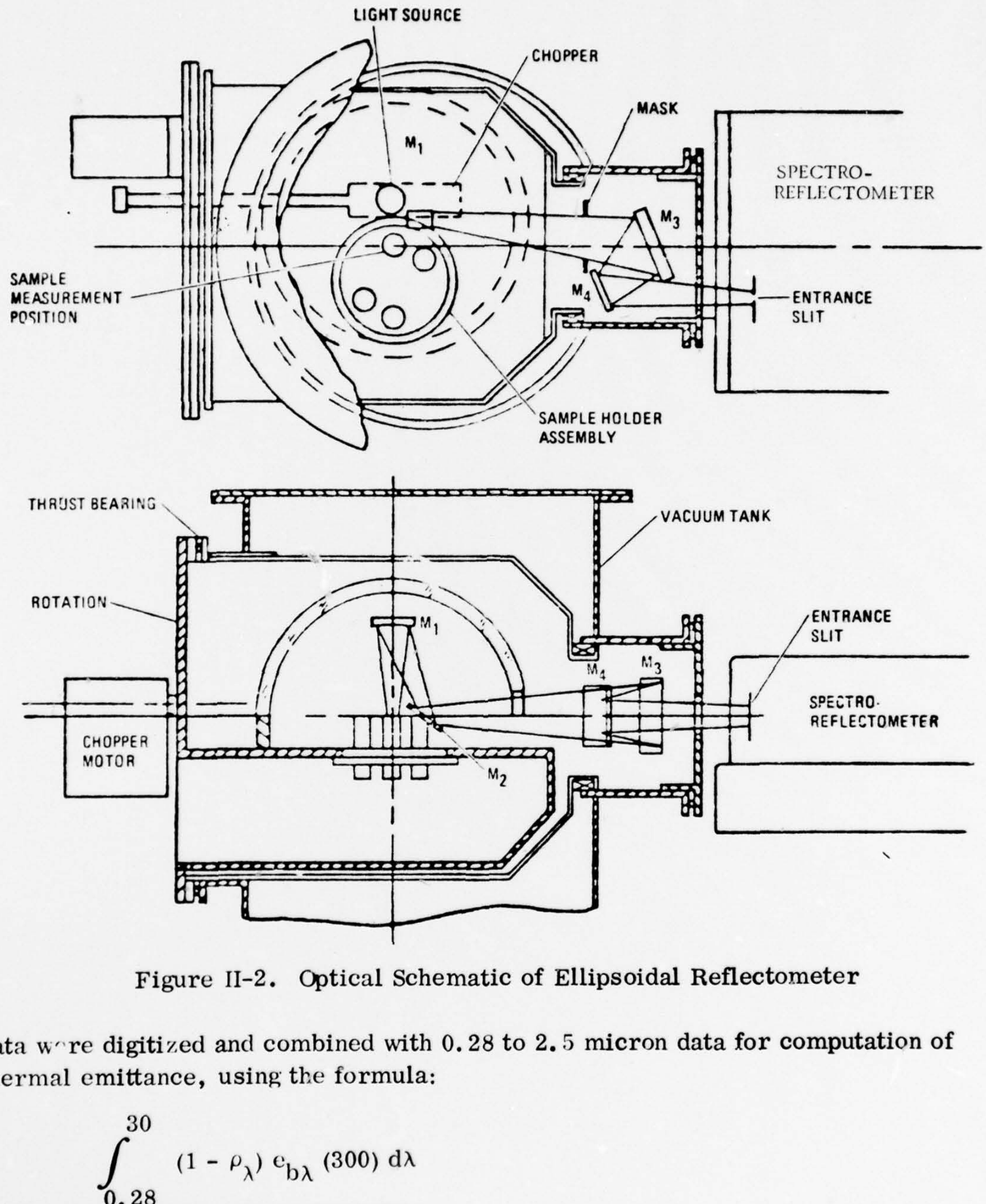

Figure II-2. Optical Schematic of Ellipsoidal Reflectometer

data were digitized and combined with 0.28 to 2.5 micron data for computation of thermal emittance, using the formula:

$$\epsilon_{300} = \frac{\int_{0.28}^{30} (1 - \rho_\lambda)\, e_{b\lambda}(300)\, d\lambda}{\int_{0.28}^{30} e_{b\lambda}(300)\, d\lambda}$$

where ρ_λ = the measured directional-hemispherical reflectance

$e_{b\lambda}$ = the Planck blackbody radiation function

ANNEX III

BIDIRECTIONAL REFLECTANCE

ANNEX III

BIDIRECTIONAL REFLECTANCE

Bidirectional reflectance measurements were made on two samples of each of the four selected designs. The measurements were made at 0.5 micron. Reflectance measurements were made at eight elevation angles for each of 12 azimuth angles, repeated for each of three incident elevation angles. The measurements were repeated for at least one other incident azimuth angle, when dictated by the nature of the sample surface; i.e., if the surface was nonisotropic. The bidirectional reflectance $\rho(\theta, \phi, \theta', \phi')$ of the selected candidate samples (Figure III-1) were determined on an absolute basis. Data is provided in tabular form (ERAS format) and in a pictorial representation for easy visualization of performance.

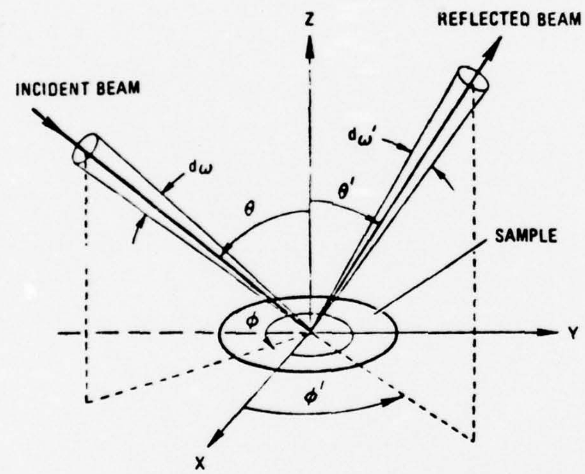

Figure III-1. Definition of Bidirectional Reflectance Angles

For the work of this project, a 100-watt Xenon arc lamp was used with the photomultiplier detector. As shown in Figure III-2, a chopper interrupts the incident radiation to provide an a-c signal for the detector system to detect and record. The chopping frequency is 1,000 Hz and a Princeton Applied Research amplifier is used. The data, recorded on a Hewlett Packard Dymec recorder, is taken in such a sequence that the paper tape from the Dymec recorder may be processed on the computer to give a computation of the data in the ERAS format. Light dispersion is provided with thin-film interference filters. Angular divergence of the rays within the beam is controlled by an aperture in front of the source and in front of the photomultiplier tube, as shown in Figure II-1 (Annex II). The source unit can be adjusted continuously over the polar angle $\theta = 0$ to 88 degrees and the azimuthal angle of the source can be varied from 0 to 360 degrees by rotating the sample. The detector position is similarly variable over similar angles; i.e., polar 0 to 88 degrees, and azimuth 0 to 360 degrees.

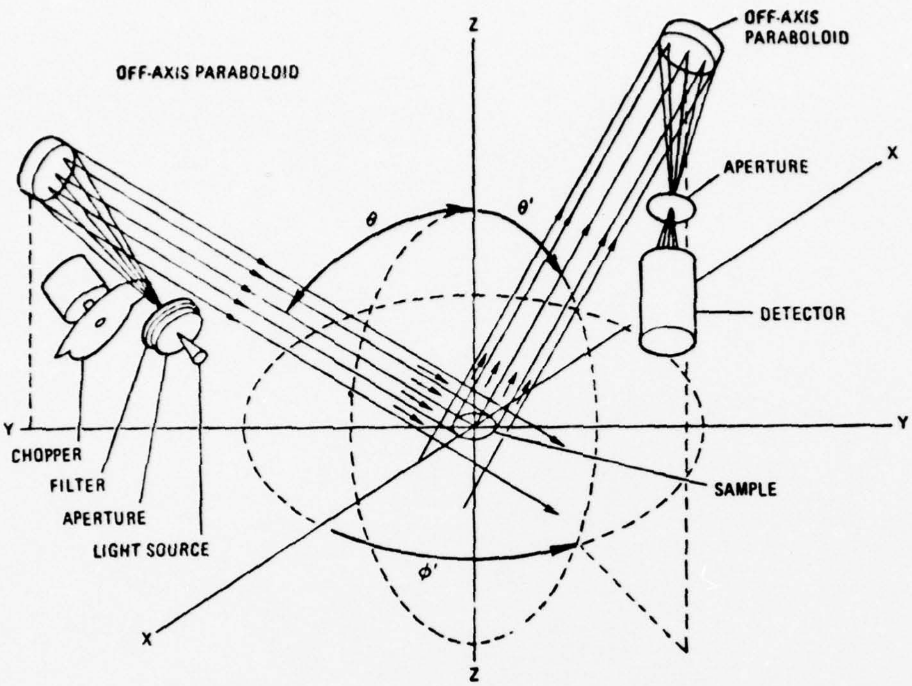

Figure III-2. Bidirectional Reflectance Apparatus

Bidirectional reflectance in this program is required in absolute terms; i.e., as the fraction of the incident energy scattered into a given solid angle. To meet this requirement, measurements were made of the total reflectance (directional reflectance) of the sample as a function of incident angle. Bidirectional reflectance measurements were made at set intervals in the 2π sr hemisphere over the sample. These measurements, taken on a relative basis (i.e., for a given incidence angle, the reflected energy at any particular angle is compared to the energy reflected at the specular angle), are then equated to the total reflectance as determined by measurement of the directional reflectance. This method eliminates the difficulties and uncertainties associated with the measurement of the solid angle of the detector system.

Data are provided in computer printout form in the ERAS format and also in a "pictorial" form for easy visualization, as illustrated in Figure III-3. This latter "picture" is obtained directly from the computer-generated tabulation, using the Stromberg Carlson SC-4020 printer and the Convair Division Computer Laboratory.

Bidirectional data reduction was accomplished in the following manner:

1. Punched paper tape from the digital data acquisition system (HP Dymec) was processed to magnetic tape by a SDC 930 computer.
2. Magnetic tape processed to raw data cards for CDC 6400.

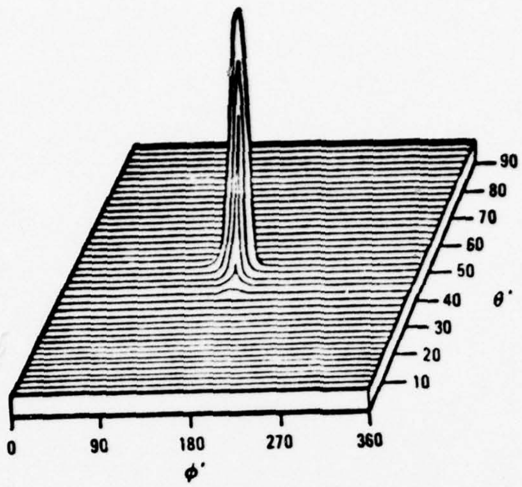

Figure III-3. Representation of Bidirectional Reflectance Data (Angles Defined in Figure III-1)

3. Raw data cards listed and edited by directional data block.

4. Bidirectional data reduction Program 5062 used to integrate actual values of bidirectional reflectance.

5. Formatting programs (CDC 6400) used to produce data blocks for use by other codes and plotted output (SC 4020, Charactron).

ANNEX IV

TEST PLAN — SECOND SURFACE MIRRORS

ANNEX IV

TEST PLAN — SECOND SURFACE MIRRORS

SAMPLE FABRICATION

Consistent with the contractual requirements eight samples of each of four designs selected by SAMSO were fabricated.

OPTICAL MEASUREMENTS

Two samples of each of the four designs were tested for optical performance. The measurements consisted of spectral measurements of directional reflectance from 0.28 to 30.0 microns and bidirectional reflectance at 0.5 micron. The directional data was digitized and integrated for solar absorptance from 0.28 to 2.5 microns, using the Air Mass Zero Solar Spectral Irradiance as per ASTM E 490-73. Thermal emittance was derived from the directional reflectance data recorded from 2.0 to 30.0 μm.

Bidirectional data was digitized and normalized to the directional data. The normalized bidirectional data was plotted in units of sr^{-1} as a function of incidence angle (nominally elevation angle; also the azimuth angle, if required by the nature of the shaped surface) and reflected angle (elevation and azimuth).

All data was reduced to the ERAS format to facilitate use by the Air Force and qualified contractors.

Detailed descriptions of apparatus and procedures for the determination of directional reflectance from 0.28 to 2.5 μm, directional reflectance from 2.0 to 30 μm, and bidirectional reflectance at 0.5 μm are discussed in detail in Annexes I, II and III.

MIL SPECIFICATIONS TESTS

Testing to MIL specifications for appearance, coating adherence, humidity resistance, hardeners, and thermal cycling were performed on two samples of each of the four selected designs. The tests performed were as follows.

<u>Appearance</u>. The coatings were observed by the unaided eye. The coated surface gave the appearance of uniform coverage. The uncoated surface was free of all metal deposition and other contaminations. The overcoated back surface had a distinct color when viewed in white light.

Coating Adherence. The specimens were immersed in boiling distilled water for five minutes. The adherence test of MIL-M-13508B, Paragraph 4.4.6, was then performed by firmly pressing tape conforming to LT-90-C against the coated surface and pulling it down over the edges of the specimen. The tape was then removed slowly.

Upon recommendation of the Program Review Board, on 3 May 1974, this adherence test was performed before and after the samples had been subjected to the tests that follow, to ensure the adherence of tne coatings after these had been subjected to the extreme conditions implied by the hardness, and humidity resistance tests, as well as the thermal cycling.

Humidity Resistance. The specimens were subjected to humidity greater than 95% at a temperature of 120 ±4F for 24 hours in a thermostatically controlled chamber approximately 3 × 3 × 3 feet, in accordance with MIL-C-675A, Paragraph 4.6.9.

Coating Hardness. The specimens were rubbed with a piece of clean, dry-laundered cheese cloth, conforming to CCC-C-271, and approximately 3/8-in. in diameter and 1/2-in. thick, a number of strokes while on the platform of a triple beam balance set for one pound. Keeping the platform depressed during rubbing ensured one-pound minimum force as specified in MIL-M-13508B, Paragraph 4.4.5. As this test was originally designed for a smooth mirror surface, rather than a rough reflecting one, a note was made as to how may strokes, if less than 50, were required to damage the surface.

Thermal Cycling. The specimens were subjected to three cycles consisting of (1) lowering the temperature from ambient to -130 ±5C (-202 ±9F), (2) a dwell of 30 minutes, (3) raising the temperature to +85 ±5C (185 ±9F), (4) a dwell of 30 minutes, and (5) return to ambient. The rate of temperature change was not less than 2C (3.6F) per minute. The control of the temperature at this rate was achieved by means of specifically built plastic or cardboard cams that controlled the switching on and off of the heating/cooling equipment. Cams were readily available for a cooling rate of 5°F/min and 4°F/min for heating.

Cooling was accomplished by liquid nitrogen entering the approximately 3 × 3 × 3 foot chamber and provided a nitrogen atmosphere inside the chamber. During heating, a dry nitrogen purge was applied until the chamber was above the dew point; thus, condensation did not form on the specimens.

PROOF OF REPRODUCIBILITY OF TESTING

Upon completion of the test phase of the program, a reproducibility check was made on the two best designs. Following the procedure documented during the fabrication phase, two samples of each type were fabricated and tested for optical performance. This check served both to demonstrate the reproducibility of the mirror designs and to verify the adequacy and reproducibility of the different tests.

DOCUMENTATION OF THE TESTS

Documentation of requirements testing was provided. The documentation included objectives, the approved test plans, a description of test equipment, and detailed test results.

ANNEX V

HEMISPHERICAL-DIRECTIONAL REFLECTANCE
0.3 TO 7.0 μm

This annex presents the hemispherical-directional (near normal) reflectance of the samples in digital form. Wavelength in micrometers is listed against reflectance from 0.3 μm to 7.0 μm.

SAMPLE FS 3-9-1.5 N4
DATE 1-31-75

WAVE LENGTH	REFLECT- ANCE	WAVE LENGTH	REFLECT- ANCE	WAVE LENGTH	REFLECT- ANCE	WAVE LENGTH	REFLECT- ANCE//
3.000E-01	1.000E-01	3.200E-01	1.420E-01	3.300E-01	5.860E-01	3.350E-01	6.780E-01
3.500E-01	8.070E-01	3.600E-01	8.380E-01	3.700E-01	8.560E-01	3.750E-01	8.650E-01
3.900E-01	8.950E-01	4.000E-01	9.080E-01	4.100E-01	9.150E-01	4.200E-01	9.250E-01
4.300E-01	9.320E-01	4.400E-01	9.310E-01	4.450E-01	9.390E-01	4.500E-01	9.370E-01
4.650E-01	9.450E-01	4.750E-01	9.450E-01	4.900E-01	9.500E-01	4.950E-01	9.500E-01
5.000E-01	9.570E-01	5.100E-01	9.570E-01	5.200E-01	9.540E-01	5.400E-01	9.590E-01
5.700E-01	9.600E-01	7.000E-01	9.700E-01	8.000E-01	9.720E-01	9.000E-01	9.710E-01
1.000E+00	9.720E-01	1.100E+00	9.700E-01	1.200E+00	9.710E-01	1.300E+00	9.700E-01
1.400E+00	9.730E-01	1.500E+00	9.730E-01	1.600E+00	9.720E-01	1.700E+00	9.700E-01
1.800E+00	9.740E-01	2.000E+00	9.750E-01	2.500E+00	9.340E-01	3.000E+00	9.180E-01
3.500E+00	9.210E-01	4.000E+00	8.450E-01	4.500E+00	6.210E-01	5.000E+00	2.400E-02
5.500E+00	0.	6.000E+00	1.700E-02	6.500E+00	0.	7.000E+00	5.000E-03
7.500E+00	0.	8.000E+00	0.	8.500E+00	0.	9.000E+00	0.
9.500E+00	0.	1.000E+01	0.	1.050E+01	0.	1.100E+01	0.
1.150E+01	0.	1.200E+01	0.	1.250E+01	0.	1.300E+01	0.
1.400E+01	0.	1.500E+01	0.	1.600E+01	0.	1.700E+01	0.
1.800E+01	0.	1.900E+01	0.	2.000E+01	0.	2.100E+01	0.
2.200E+01	0.	2.300E+01	0.	2.400E+01	0.	2.500E+01	0.
2.600E+01	0.	2.700E+01	0.	2.800E+01	0.	2.900E+01	0.
3.000E+01	0.	3.100E+01	0.	3.200E+01	0.	-0.	-0.

SOLAR ABSORPTANCE =7.145001E-02

TABLE V-1. FS 3-9-1.5 N4

SAMPLE FS 3-9-2.5 N4
DATE 1-31-75

WAVE LENGTH	REFLECT-ANCE	WAVE LENGTH	REFLECT-ANCE	WAVE LENGTH	REFLECT-ANCE	WAVE LENGTH	REFLECT-ANCE//
3.000E-01	1.000E-02	3.200E-01	1.510E-01	3.300E-01	6.000E-01	3.350E-01	6.890E-01
3.500E-01	9.200E-01	3.600E-01	8.480E-01	3.700E-01	8.660E-01	3.750E-01	8.770E-01
3.900E-01	9.000E-01	4.000E-01	9.130E-01	4.100E-01	9.270E-01	4.200E-01	9.290E-01
4.300E-01	9.390E-01	4.400E-01	9.410E-01	4.450E-01	9.450E-01	4.500E-01	9.490E-01
4.650E-01	9.500E-01	4.750E-01	9.510E-01	4.900E-01	9.530E-01	4.950E-01	9.580E-01
5.000E-01	9.590E-01	5.100E-01	9.590E-01	5.200E-01	9.620E-01	5.400E-01	9.660E-01
5.700E-01	9.670E-01	7.000E-01	9.700E-01	8.000E-01	9.720E-01	9.000E-01	9.720E-01
1.000E+00	9.730E-01	1.100E+00	9.730E-01	1.200E+00	9.710E-01	1.300E+00	9.750E-01
1.400E+00	9.700E-01	1.500E+00	9.720E-01	1.600E+00	9.700E-01	1.700E+00	9.730E-01
1.800E+00	9.750E-01	2.000E+00	9.700E-01	2.500E+00	9.410E-01	3.000E+00	9.260E-01
3.500E+00	9.300E-01	4.000E+00	8.610E-01	4.500E+00	6.470E-01	5.000E+00	2.530E-02
5.500E+00	0.	6.000E+00	1.600E-02	6.500E+00	0.	7.000E+00	5.0[illegible]0E-03
7.500E+00	0.	8.000E+00	0.	8.500E+00	0.	9.000E+00	0.
9.500E+00	0.	1.000E+01	0.	1.050E+01	0.	1.100E+01	0.
1.150E+01	0.	1.200E+01	0.	1.250E+01	0.	1.300E+01	0.
1.400E+01	0.	1.500E+01	0.	1.600E+01	0.	1.700E+01	0.
1.900E+01	0.	1.900E+01	0.	2.000E+01	0.	2.100E+01	0.
2.200E+01	0.	2.300E+01	0.	2.400E+01	0.	2.550E+01	0.
2.600E+01	0.	2.700E+01	0.	2.800E+01	0.	2.900E+01	0.
3.000E+01	0.	3.100E+01	0.	3.200E+01	0.	-0.	-0.

SOLAR ABSORPTANCE =6.9254155E-02

TABLE V-2 FS 3-9-2.5 N4

SAMPLE FS 30-P-0.5 N4
DATE 1-31-75

WAVE LENGTH	REFLECT-ANCE	WAVE LENGTH	REFLECT-ANCE	WAVE LENGTH	REFLECT-ANCE	WAVE LENGTH	REFLECT-ANCE//
3.000E-01	9.200E-02	3.200E-01	1.420E-01	3.300E-01	5.370E-01	3.350E-01	6.180E-01
3.500E-01	7.590E-01	3.600E-01	7.920E-01	3.700E-01	8.170E-01	3.750E-01	8.250E-01
3.900E-01	8.600E-01	4.000E-01	8.730E-01	4.100E-01	8.840E-01	4.200E-01	9.020E-01
4.300E-01	9.090E-01	4.400E-01	9.170E-01	4.450E-01	9.190E-01	4.500E-01	9.200E-01
4.650E-01	9.280E-01	4.750E-01	9.290E-01	4.900E-01	9.330E-01	4.950E-01	9.360E-01
5.000E-01	9.450E-01	5.100E-01	9.400E-01	5.200E-01	9.420E-01	5.400E-01	9.490E-01
5.750E-01	9.500E-01	7.000E-01	9.620E-01	8.000E-01	9.720E-01	9.000E-01	9.730E-01
1.000E+00	9.730E-01	1.100E+00	9.700E-01	1.200E+00	9.720E-01	1.300E+00	9.700E-01
1.400E+00	9.690E-01	1.500E+00	9.720E-01	1.600E+00	9.700E-01	1.700E+00	9.700E-01
1.800E+00	9.690E-01	2.000E+00	9.720E-01	2.500E+00	9.160E-01	3.000E+00	8.910E-01
3.500E+00	9.040E-01	4.000E+00	8.230E-01	4.500E+00	6.070E-01	5.000E+00	2.000E-02
5.500E+00	0.	6.000E+00	1.400E-02	6.500E+00	0.	7.000E+00	4.[illegible]E-03
7.500E+00	0.	8.000E+00	0.	8.500E+00	0.	9.000E+00	0.
9.500E+00	0.	1.000E+01	0.	1.050E+01	0.	1.100E+01	0.
1.150E+01	0.	1.200E+01	0.	1.250E+01	0.	1.300E+01	0.
1.400E+01	0.	1.500E+01	0.	1.600E+01	0.	1.700E+01	0.
1.800E+01	0.	1.900E+01	0.	2.000E+01	0.	2.100E+01	0.
2.200E+01	0.	2.300E+01	0.	2.400E+01	0.	2.500E+01	0.
2.600E+01	0.	2.700E+01	0.	2.800E+01	0.	2.900E+01	0.
3.000E+01	0.	3.100E+01	0.	3.200E+01	0.	-0.	-0.

SOLAR ABSORPTANCE =9.950755E-02

TABLE V-3 FW 30-P-C 5 N4

SAMPLE FS 3-9-1.5 E6
DATE 1-31-75

WAVE LENGTH	REFLECT-ANCE	WAVE LENGTH	REFLECT-ANCE	WAVE LENGTH	REFLECT-ANCE	WAVE LENGTH	REFLECT-ANCE//
3.000E-01	4.820E-01	3.200E-01	5.680E-01	3.300E-01	6.480E-01	3.350E-01	6.780E-01
3.500E-01	7.850E-01	3.600E-01	8.390E-01	3.700E-01	8.960E-01	3.750E-01	9.090E-01
3.900E-01	9.350E-01	4.000E-01	9.430E-01	4.100E-01	9.430E-01	4.200E-01	9.430E-01
4.300E-01	9.410E-01	4.400E-01	9.470E-01	4.450E-01	9.490E-01	4.500E-01	9.500E-01
4.650E-01	9.430E-01	4.750E-01	9.500E-01	4.900E-01	9.510E-01	4.950E-01	9.500E-01
5.000E-01	9.530E-01	5.100E-01	9.500E-01	5.200E-01	9.500E-01	5.400E-01	9.500E-01
5.700E-01	9.500E-01	7.000E-01	9.540E-01	8.000E-01	9.590E-01	9.000E-01	9.600E-01
1.000E+00	9.590E-01	1.100E+00	9.530E-01	1.200E+00	9.590E-01	1.300E+00	9.600E-01
1.400E+00	9.590E-01	1.500E+00	9.600E-01	1.600E+00	9.600E-01	1.700E+00	9.590E-01
1.800E+00	9.600E-01	2.000E+00	9.600E-01	2.500E+00	9.170E-01	3.000E+00	7.440E-01
3.500E+00	9.650E-01	4.000E+00	8.240E-01	4.500E+00	6.2[illegible]0E-01	5.000E+00	4.330E-02
5.500E+00	0.	6.000E+00	3.200E-02	6.500E+00	0.	7.000E+00	2.430E-02
7.500E+00	0.	8.000E+00	0.	8.500E+00	0.	9.000E+00	0.
9.500E+00	0.	1.000E+01	0.	1.050E+01	0.	1.100E+01	0.
1.150E+01	0.	1.200E+01	0.	1.250E+01	0.	1.300E+01	0.
1.400E+01	0.	1.500E+01	0.	1.600E+01	0.	1.700E+01	0.
1.800E+01	0.	1.900E+01	0.	2.000E+01	0.	2.100E+01	0.
2.200E+01	0.	2.300E+01	0.	2.400E+01	0.	2.500E+01	0.
2.600E+01	0.	2.700E+01	0.	2.800E+01	0.	2.900E+01	0.
3.000E+01	0.	3.100E+01	0.	3.200E+01	0.	-0.	-0.

SOLAR ABSORPTANCE =7.257026E-02

TABLE V-4. FS 3-9-1.5 E6

SAMPLE FS 3-9-2.5 E6
DATE 1-31-73

WAVE LENGTH	REFLECT-ANCE	WAVE LENGTH	REFLECT-ANCE	WAVE LENGTH	REFLECT-ANCE	WAVE LENGTH	REFLECT-ANCE
3.000E-01	6.200E-01	3.200E-01	6.180E-01	3.300E-01	6.890E-01	3.350E-01	6.240E-01
3.500E-01	8.340E-01	3.600E-01	8.450E-01	3.700E-01	9.250E-01	3.750E-01	9.420E-01
3.900E-01	9.660E-01	4.000E-01	9.700E-01	4.100E-01	9.690E-01	4.200E-01	9.690E-01
4.300E-01	9.690E-01	4.400E-01	9.690E-01	4.450E-01	9.690E-01	4.500E-01	9.650E-01
4.650E-01	9.690E-01	4.750E-01	9.700E-01	4.900E-01	9.680E-01	4.950E-01	9.680E-01
5.000E-01	9.690E-01	5.100E-01	9.690E-01	5.200E-01	9.700E-01	5.400E-01	9.640E-01
5.700E-01	9.6[illegible]0E-01	7.000E-01	9.640E-01	8.000E-01	9.650E-01	9.000E-01	9.700E-01
1.000E+00	9.720E-01	1.100E+00	9.630E-01	1.200E+00	9.650E-01	1.300E+00	9.610E-01
1.400E+00	9.700E-01	1.500E+00	9.690E-01	1.600E+00	9.700E-01	1.700E+00	9.640E-01
1.800E+00	9.710E-01	2.000E+00	9.650E-01	2.500E+00	9.400E-01	3.000E+00	7.850E-01
3.500E+00	8.990E-01	4.000E+00	8.670E-01	4.500E+00	6.920E-01	5.000E+00	5.100E-02
5.500E+00	0.	6.000E+00	3.700E-02	6.500E+00	0.	7.000E+00	2.800E-02
7.500E+00	0.	8.000E+00	0.	9.500E+00	0.	9.000E+00	0.
9.500E+00	0.	1.000E+01	0.	1.050E+01	0.	1.100E+01	0.
1.150E+01	0.	1.200E+01	0.	1.250E+01	0.	1.300E+01	0.
1.400E+01	0.	1.500E+01	0.	1.600E+01	0.	1.700E+01	0.
1.800E+01	0.	1.900E+01	0.	2.000E+01	0.	2.100E+01	0.
2.200E+01	0.	2.300E+01	0.	2.400E+01	0.	2.500E+01	0.
2.600E+01	0.	2.700E+01	0.	2.800E+01	0.	2.900E+01	0.
3.000E+01	0.	3.100E+01	0.	3.200E+01	0.	-0.	-0.

SOLAR ABSORPTANCE =5.937294E-02

TABLE V-5. FS 3-9.2.5 E6

SAMPLE FS 30-P-0.5 E6
DATE 1-31-75

WAVE LENGTH	REFLECT-ANCE	WAVE LENGTH	REFLECT-ANCE	WAVE LENGTH	REFLECT-ANCE	WAVE LENGTH	REFLECT-ANCE
3.000E-01	4.190E-01	3.200E-01	5.020E-01	3.300E-01	5.790E-01	3.350E-01	6.090E-01
3.500E-01	7.670E-01	3.600E-01	7.870E-01	3.700E-01	8.370E-01	3.750E-01	8.430E-01
3.900E-01	8.950E-01	4.000E-01	9.110E-01	4.100E-01	9.140E-01	4.200E-01	9.120E-01
4.300E-01	9.250E-01	4.400E-01	9.270E-01	4.450E-01	9.280E-01	4.500E-01	9.280E-01
4.650E-01	9.300E-01	4.750E-01	9.320E-01	4.900E-01	9.380E-01	4.950E-01	9.360E-01
5.000E-01	9.230E-01	5.100E-01	9.300E-01	5.200E-01	9.330E-01	5.400E-01	9.380E-01
5.700E-01	9.470E-01	7.000E-01	9.540E-01	8.000E-01	9.510E-01	9.000E-01	9.600E-01
1.000E+00	9.630E-01	1.100E+00	9.530E-01	1.200E+00	9.580E-01	1.300E+00	9.600E-01
1.400E+00	9.690E-01	1.500E+00	9.620E-01	1.600E+00	9.600E-01	1.700E+00	9.620E-01
1.800E+00	9.680E-01	2.000E+00	9.600E-01	2.500E+00	9.190E-01	3.000E+00	7.240E-01
3.500E+00	9.640E-01	4.000E+00	8.300E-01	4.500E+00	6.660E-01	5.000E+00	5.200E-02
5.500E+00	0.	6.000E+00	3.700E-02	6.500E+00	0.	7.000E+00	2.430E-02
7.500E+00	0.	8.000E+00	0.	8.500E+00	0.	9.000E+00	0.
9.500E+00	0.	1.000E+01	0.	1.050E+01	0.	1.100E+01	0.
1.150E+01	0.	1.200E+01	0.	1.250E+01	0.	1.300E+01	0.
1.400E+01	0.	1.500E+01	0.	1.600E+01	0.	1.700E+01	0.
1.800E+01	0.	1.900E+01	0.	2.000E+01	0.	2.100E+01	0.
2.200E+01	0.	2.300E+01	0.	2.400E+01	0.	2.500E+01	0.
2.600E+01	0.	2.700E+01	0.	2.800E+01	0.	2.900E+01	0.
3.000E+01	0.	3.100E+01	0.	3.200E+01	0.	-0.	-0.

SOLAR ABSORPTANCE =9.1987565E-02

TABLE V-6. FS 30-P-0.5 E6

SAMPLE FEP 3-9Q-GTS-1
DATE 1-31-75

WAVE LENGTH	REFLECT-ANCE	WAVE LENGTH	REFLECT-ANCE	WAVE LENGTH	REFLECT-ANCE	WAVE LENGTH	REFLECT-ANCE//
3.000E-01	1.300E-01	3.290E-01	1.339E-01	3.330E-01	4.840E-01	3.350E-01	5.850E-01
3.500E-01	6.740E-01	3.600E-01	6.763E-01	3.700E-01	6.990E-01	3.750E-01	7.090E-01
3.900E-01	7.600E-01	4.000E-01	7.830E-01	4.100E-01	8.040E-01	4.200E-01	8.250E-01
4.390E-01	8.360E-01	4.400E-01	8.500E-01	4.450E-01	8.560E-01	4.500E-01	8.600E-01
4.650E-01	8.730E-01	4.750E-01	8.760E-01	4.900E-01	8.870E-01	4.950E-01	8.890E-01
5.000E-01	8.950E-01	5.100E-01	9.000E-01	5.200E-01	9.000E-01	5.400E-01	9.100E-01
5.700E-01	9.190E-01	7.000E-01	9.470E-01	9.000E-01	9.520E-01	9.000E-01	9.650E-01
1.000E+00	9.710E-01	1.100E+00	9.700E-01	1.200E+00	9.700E-01	1.300E+00	9.790E-01
1.400E+00	9.730E-01	1.500E+00	9.750E-01	1.600E+00	9.750E-01	1.700E+00	9.830E-01
1.900E+00	9.710E-01	2.000E+00	9.800E-01	2.500E+00	9.430E-01	3.000E+00	9.290E-01
3.500E+00	9.090E-01	4.000E+00	4.100E-01	4.500E+00	7.920E-01	5.000E+00	6.830E-01
5.500E+00	0.	6.000E+00	5.250E-01	6.500E+00	0.	7.000E+00	1.930E-01
7.500E+00	0.	8.000E+00	0.	8.500E+00	0.	9.000E+00	0.
9.500E+00	0.	1.000E+01	0.	1.050E+01	0.	1.100E+01	0.
1.150E+01	0.	1.200E+01	0.	1.250E+01	0.	1.300E+01	0.
1.400E+01	0.	1.500E+01	0.	1.600E+01	0.	1.700E+01	0.
1.800E+01	0.	1.900E+01	0.	2.000E+01	0.	2.100E+01	0.
2.200E+01	0.	2.300E+01	0.	2.400E+01	0.	2.500E+01	0.
2.600E+01	0.	2.700E+01	0.	2.800E+01	0.	2.900E+01	0.
3.000E+01	0.	3.100E+01	0.	3.200E+01	0.	-0.	-0.

SOLAR ABSORPTANCE =9.962141E-02

TABLE V-1. FEP 3-9Q-GTS-1

SAMPLE FEP 3-90 GTS-2
DATE 1-31-75

WAVE LENGTH	REFLECT-ANCE	WAVE LENGTH	REFLECT-ANCE	WAVE LENGTH	REFLECT-ANCE	WAVE LENGTH	REFLECT-ANCE//
3.000E-01	1.290E-01	3.200E-01	1.300E-01	3.300E-01	4.840E-01	3.350E-01	5.800E-01
3.500E-01	6.590E-01	3.600E-01	6.500E-01	3.700E-01	6.590E-01	3.750E-01	6.670E-01
3.900E-01	7.230E-01	4.000E-01	7.540E-01	4.100E-01	7.730E-01	4.200E-01	7.990E-01
4.300E-01	8.130E-01	4.400E-01	8.310E-01	4.450E-01	8.400E-01	4.500E-01	8.460E-01
4.650E-01	8.580E-01	4.750E-01	8.690E-01	4.900E-01	8.760E-01	4.950E-01	8.800E-01
5.000E-01	8.960E-01	[illegible]	[illegible]	5.200E-01	8.940E-01	5.400E-01	9.000E-01
5.700E-01	9.150E-01	7.300E-01	9.500E-01	8.000E-01	9.540E-01	9.000E-01	9.570E-01
1.000E+00	9.690E-01	1.100E+00	9.620E-01	1.200E+00	9.650E-01	1.300E+00	9.690E-01
1.400E+00	9.680E-01	1.500E+00	9.740E-01	1.600E+00	9.700E-01	1.700E+00	9.760E-01
1.800E+00	9.700E-01	2.000E+00	9.700E-01	2.500E+00	9.260E-01	3.000E+00	9.070E-01
3.500E+00	8.910E-01	4.000E+00	3.790E-01	4.500E+00	6.780E-01	5.000E+00	6.630E-01
5.500E+00	0.	6.000E+00	4.900E-01	6.500E+00	0.	7.000E+00	1.710E-01
7.500E+00	0.	9.000E+00	0.	8.500E+00	0.	9.000E+00	0.
9.500E+00	0.	1.000E+01	0.	1.050E+01	0.	1.100E+01	0.
1.150E+01	0.	1.200E+01	0.	1.250E+01	0.	1.300E+01	0.
1.400E+01	0.	1.500E+01	0.	1.600E+01	0.	1.700E+01	0.
1.800E+01	0.	1.900E+01	0.	2.000E+01	0.	2.100E+01	0.
2.200E+01	0.	2.300E+01	0.	2.400E+01	0.	2.500E+01	0.
2.600E+01	0.	2.700E+01	0.	2.800E+01	0.	2.900E+01	0.
3.000E+01	0.	3.100E+01	0.	3.200E+01	0.	-0.	-0.

SOLAR ABSORPTANCE =1.?702535E-01

TABLE V-8. FEP 3-90 GTS-2

SAMPLE MSI-100 LOG S-1
DATE 1-75

WAVE LENGTH	REFLECT-ANCE	WAVE LENGTH	REFLECT-ANCE	WAVE LENGTH	REFLECT-ANCE	WAVE LENGTH	REFLECT-ANCE//
3.000E-01	5.940E-01	3.200E-01	9.880E-01	3.300E-01	9.980E-01	3.350E-01	9.940E-01
3.500E-01	9.000E-01	3.600E-01	9.630E-01	3.700E-01	9.850E-01	3.750E-01	9.900E-01
3.900E-01	9.800E-01	4.000E-01	9.750E-01	4.100E-01	9.460E-01	4.200E-01	9.350E-01
4.300E-01	9.530E-01	4.400E-01	9.600E-01	4.450E-01	9.680E-01	4.500E-01	9.760E-01
4.650E-01	9.770E-01	4.750E-01	9.790E-01	4.900E-01	9.850E-01	4.950E-01	9.800E-01
5.000E-01	9.790E-01	5.100E-01	9.790E-01	5.200E-01	9.780E-01	5.400E-01	9.600E-01
5.700E-01	9.900E-01	7.000E-01	9.890E-01	6.000E-01	9.950E-01	9.000E-01	9.940E-01
1.000E+00	9.960E-01	1.100E+00	9.850E-01	1.200E+00	9.900E-01	1.300E+00	9.910E-01
1.400E+00	9.900E-01	1.500E+00	9.920E-01	1.600E+00	9.630E-01	1.700E+00	9.900E-01
1.800E+00	9.900E-01	2.100E+00	9.900E-01	2.500E+00	9.410E-01	3.000E+00	9.260E-01
3.500E+00	9.300E-01	4.000E+00	8.610E-01	4.500E+00	6.470E-01	5.000E+00	2.500E-02
5.500E+00	0.	6.000E+00	1.600E-02	6.500E+00	0.	7.000E+00	5.000E-03
7.500E+00	0.	8.000E+00	0.	8.500E+00	0.	9.000E+00	0.
9.500E+00	0.	1.000E+01	0.	1.050E+01	0.	1.100E+01	0.
1.150E+01	0.	1.200E+01	0.	1.250E+01	0.	1.300E+01	0.
1.400E+01	0.	1.500E+01	0.	1.600E+01	0.	1.700E+01	0.
1.800E+01	0.	1.900E+01	0.	2.000E+01	0.	2.100E+01	0.
2.200E+01	0.	2.300E+01	0.	2.400E+01	0.	2.500E+01	0.
2.600E+01	0.	2.700E+01	0.	2.800E+01	0.	2.900E+01	0.
3.000E+01	0.	3.100E+01	0.	3.200E+01	0.	-0.	-0.

SOLAR ABSORPTANCE =2.799192E-02

TABLE V-9. MSI-100 LOG S-1

SAMPLE SI-100 LOG S-2
DATE 1-31-75

WAVE LENGTH	REFLECT-ANCE	WAVE LENGTH	REFLECT-ANCE	WAVE LENGTH	REFLECT-ANCE	WAVE LENGTH	REFLECT-ANCE//
3.000E-01	1.060E-01	3.200E-01	1.490E-01	3.300E-01	5.880E-01	3.350E-01	6.670E-01
3.500E-01	8.040E-01	3.600E-01	8.350E-01	3.700E-01	8.520E-01	3.750E-01	8.650E-01
3.900E-01	8.970E-01	4.000E-01	9.020E-01	4.100E-01	9.140E-01	4.200E-01	9.270E-01
4.300E-01	9.390E-01	4.400E-01	9.480E-01	4.450E-01	9.500E-01	4.500E-01	9.540E-01
4.650E-01	9.620E-01	4.750E-01	9.630E-01	4.900E-01	9.790E-01	4.950E-01	9.700E-01
5.000E-01	9.700E-01	5.100E-01	9.750E-01	5.200E-01	9.680E-01	5.400E-01	9.750E-01
5.700E-01	9.700E-01	7.000E-01	9.900E-01	8.000E-01	9.870E-01	9.000E-01	9.970E-01
1.000E+00	9.940E-01	1.100E+00	9.960E-01	1.200E+00	9.900E-01	1.300E+00	9.920E-01
1.400E+00	9.910E-01	1.500E+00	9.970E-01	1.600E+00	9.920E-01	1.700E+00	9.960E-01
1.800E+00	9.980E-01	2.000E+00	9.920E-01	2.500E+00	9.410E-01	3.000E+00	9.260E-01
3.500E+00	9.300E-01	4.000E+00	8.610E-01	4.500E+00	6.470E-01	5.000E+00	2.500E-02
5.500E+00	0.	6.000E+00	1.600E-02	6.500E+00	0.	7.000E+00	5.000E-03
7.500E+00	0.	8.000E+00	0.	8.500E+00	0.	9.000E+00	0.
9.500E+00	0.	1.000E+01	0.	1.050E+01	0.	1.100E+01	0.
1.150E+01	0.	1.200E+01	0.	1.250E+01	0.	1.300E+01	0.
1.400E+01	0.	1.500E+01	0.	1.600E+01	0.	1.700E+01	0.
1.850E+01	0.	1.900E+01	0.	2.000E+01	0.	2.100E+01	0.
2.200E+01	0.	2.300E+01	0.	2.400E+01	0.	2.500E+01	0.
2.600E+01	0.	2.700E+01	0.	2.800E+01	0.	2.900E+01	0.
3.000E+01	0.	3.100E+01	0.	3.200E+01	0.	-0.	-0.

SOLAR ABSORPTANCE =5.504233E-02

TABLE V-10. SI-100 LOG S-2

SAMPLE N-4 STANDARD
DATE 1-75

WAVE LENGTH	REFLECT-ANCE	WAVE LENGTH	REFLECT-ANCE	WAVE LENGTH	REFLECT-ANCE	WAVE LENGTH	REFLECT-ANCE//
3.000E-01	1.050E-01	3.200E-01	1.290E-01	3.300E-01	5.480E-01	3.350E-01	6.820E-01
3.500E-01	8.290E-01	3.600E-01	8.590E-01	3.700E-01	8.800E-01	3.750E-01	8.960E-01
3.900E-01	9.170E-01	4.000E-01	9.280E-01	4.100E-01	9.390E-01	4.200E-01	9.450E-01
4.300E-01	9.520E-01	4.400E-01	9.590E-01	4.450E-01	9.580E-01	4.500E-01	9.590E-01
4.650E-01	9.630E-01	4.750E-01	9.620E-01	4.900E-01	9.700E-01	4.950E-01	9.690E-01
5.100E-01	9.700E-01	5.100E-01	9.700E-01	5.200E-01	9.740E-01	5.450E-01	9.780E-01
5.700E-01	9.820E-01	7.000E-01	9.870E-01	6.000E-01	9.910E-01	9.000E-01	9.980E-01
1.000E+00	9.980E-01	1.100E+00	9.980E-01	1.200E+00	9.900E-01	1.300E+00	9.940E-01
1.400E+00	9.900E-01	1.500E+00	9.950E-01	1.600E+00	9.950E-01	1.700E+00	9.980E-01
1.800E+00	9.900E-01	2.000E+00	9.900E-01	2.500E+00	9.410E-01	3.000E+00	9.260E-01
3.500E+00	9.300E-01	4.000E+00	8.610E-01	4.500E+00	6.470E-01	5.000E+00	2.500E-02
5.500E+00	0.	6.000E+00	1.630E-02	6.500E+00	0.	7.000E+00	5.000E-03
7.500E+00	0.	8.000E+00	0.	8.500E+00	0.	9.000E+00	0.
9.500E+00	0.	1.000E+01	0.	1.050E+01	0.	1.100E+01	0.
1.150E+01	0.	1.200E+01	0.	1.250E+01	0.	1.300E+01	0.
1.400E+01	0.	1.500E+01	0.	1.600E+01	0.	1.700E+01	0.
1.800E+01	0.	1.900E+01	0.	2.000E+01	0.	2.100E+01	0.
2.200E+01	0.	2.300E+01	0.	2.400E+01	0.	2.500E+01	0.
2.600E+01	0.	2.700E+01	0.	2.800E+01	0.	2.900E+01	0.
3.000E+01	0.	3.100E+01	0.	3.200E+01	0.	-0.	-0.

SOLAR ABSORPTANCE =5.224505E-02

TABLE V-11. N-4 STANDARD

ANNEX VI

DIRECTIONAL-HEMISPHERICAL REFLECTANCE ERAS FORMAT

This annex presents the directional-hemispherical reflectance for the samples in the ERAS format. Wavelength in micrometers is listed against reflectance from 0.3 μm to 29 μm.

F033520015001											
F033520015101											
F033520015102											
F033520015103											

TABLE VI-1. FS 3-9-2.5-N-4

F033520015104											
F033520017001											
F033520017002											
F033520017004						760.					
F033520019001	1		001001	.3	29.0	54				18.	
F033520019201	1	.3	10.0	.4	91.3	.5	95.8	.6	97.0	.7	97.0
F033520019202	1	.8	97.2	.9	97.2	1.0	97.9	1.1	97.3	1.2	97.1
F033520019203	1	1.3	97.5	1.4	97.0	1.5	97.2	1.6	97.0	1.7	97.0
F033520019204	1	1.8	97.5	1.9	97.9	2.0	97.0	2.5	94.1	3.0	92.6
F033520019205	1	3.5	93.0	4.0	86.1	4.5	64.7	5.0	2.5	5.5	2.1
F033520019206	1	6.0	1.6	6.5	1.1	7.0	.5	7.5	.2	8.0	19.0
F033520019207	1	8.5	39.4	9.0	64.6	9.5	33.1	10.0	18.2	10.5	11.9
F033520019208	1	11.0	9.2	11.5	6.5	12.0	6.1	12.5	8.6	13.0	7.4
F033520019209	1	14.0	5.8	15.0	4.5	16.0	4.2	17.0	2.7	18.0	2.1
F033520019210	1	19.0	3.3	20.0	26.2	21.0	54.5	22.0	38.9	23.0	27.0
F033520019211	1	24.0	23.6	25.0	19.5	27.0	15.8	29.0	15.0		
F033520025001											
F033520025101											
F033520025102											
F033520025103											

TABLE VI-2. FS 3-9-2.5-E-8

F033520025104											
F033520027001											
F033520027002											
F033520027004						760.					
F033520029001	1		001001	.3	29.0	54				18.	
F033520029201	1	.3	52.0	.4	97.0	.5	96.9	.6	96.1	.7	96.4
F033520029202	1	.8	96.5	.9	97.0	1.0	97.2	1.1	96.3	1.2	96.5
F033520029203	1	1.3	96.1	1.4	97.0	1.5	96.9	1.6	97.0	1.7	96.4
F033520029204	1	1.8	97.1	1.9	97.0	2.0	96.5	2.5	94.0	3.0	78.4
F033520029205	1	3.5	89.8	4.0	86.7	4.5	69.2	5.0	5.1	5.5	4.2
F033520029206	1	6.0	3.7	6.5	3.3	7.0	2.8	7.5	2.6	8.0	23.6
F033520029207	1	8.5	39.9	9.0	64.7	9.5	33.6	10.0	19.5	10.5	13.7
F033520029208	1	11.0	10.9	11.5	8.1	12.0	7.9	12.5	10.2	13.0	9.5
F033520029209	1	14.0	7.2	15.0	6.8	16.0	6.0	17.0	5.2	18.0	4.0
F033520029210	1	19.0	4.4	20.0	26.6	21.0	53.1	22.0	38.0	23.0	29.3
F033520029211	1	24.0	24.6	25.0	21.1	27.0	17.2	29.0	15.7		
F033530015001											
F033530015101											
F033530015102											
F033530015103											

TABLE VI-3. FS 3-9-1.5-N-4

F033530015104											
F033530017001											
F033530017002											
F033530017004						760.					
F033530019001	1		001001	.3	29.0	54				18.	
F033530019201	1	.3	10.0	.4	90.8	.5	95.7	.6	96.5	.7	97.0
F033530019202	1	.8	97.2	.9	97.1	1.0	97.2	1.1	97.0	1.2	97.1
F033530019203	1	1.3	97.0	1.4	97.3	1.5	97.3	1.6	97.2	1.7	97.0
F033530019204	1	1.8	97.4	1.9	97.9	2.0	97.5	2.5	93.4	3.0	91.8
F033530019205	1	3.5	92.1	4.0	84.5	4.5	62.1	5.0	2.4	5.5	2.1
F033530019206	1	6.0	1.7	6.5	1.0	7.0	.5	7.5	.5	8.0	19.4
F033530019207	1	8.5	39.8	9.0	64.8	9.5	33.3	10.0	20.8	10.5	11.7
F033530019208	1	11.0	9.3	11.5	6.5	12.0	6.3	12.5	8.8	13.0	7.4
F033530019209	1	14.0	5.9	15.0	4.2	16.0	4.2	17.0	2.5	18.0	1.9
F033530019210	1	19.0	2.6	20.0	25.7	21.0	54.0	22.0	38.4	23.0	26.0
F033530019211	1	24.0	24.4	25.0	19.4	27.0	15.3	29.0	15.5		

TABLE VI-4. FS 3-9-1.5-E-6

F033530025001											
F033530025101											
F033530025102											
F033530025103											
F033530025104											
F033530027001											
F033530027002											
F033530027004						760.					
F033530029001	1		001001	.3	29.0	54				18.	
F033530029201	1	.3	48.2	.4	94.3	.5	95.0	.6	95.3	.7	95.4
F033530029202	1	.8	95.9	.9	96.0	1.0	95.9	1.1	95.3	1.2	95.9
F033530029203	1	1.3	96.0	1.4	95.9	1.5	96.0	1.6	96.0	1.7	95.8
F033530029204	1	1.8	96.0	1.9	96.2	2.0	96.0	2.5	91.7	3.0	74.4
F033530029205	1	3.5	86.5	4.0	82.4	4.5	62.6	5.0	4.3	5.5	3.9
F033530029206	1	6.0	3.2	6.5	3.1	7.0	2.4	7.5	2.4	8.0	23.9
F033530029207	1	8.5	39.5	9.0	63.9	9.5	33.8	10.0	19.4	10.5	13.3
F033530029208	1	11.0	11.0	11.5	7.9	12.0	7.9	12.5	10.2	13.0	9.6
F033530029209	1	14.0	7.3	15.0	6.4	16.0	5.8	17.0	4.8	18.0	4.4
F033530029210	1	19.0	4.4	20.0	25.9	21.0	52.2	22.0	39.0	23.0	29.9
F033530029211	1	24.0	23.8	25.0	21.2	27.0	18.4	29.0	16.5		

TABLE VI-5. FS 30-P-0.5-N-4

F033540015001											
F033540015101											
F033540015102											
F033540015103											
F033540015104											
F033540017001											
F033540017002											
F033540017004						760.					
F033540019001	1		001001	.3	29.0	54				18.	
F033540019201	1	.3	9.2	.4	87.3	.5	94.5	.6	95.7	.7	96.2
F033540019202	1	.8	97.2	.9	97.3	1.0	97.2	1.1	97.0	1.2	96.2
F033540019203	1	1.3	97.0	1.4	96.9	1.5	97.2	1.6	97.0	1.7	97.0
F033540019204	1	1.8	96.9	1.9	96.7	2.0	97.1	2.5	91.6	3.0	89.1
F033540019205	1	3.5	90.4	4.0	82.3	4.5	60.7	5.0	2.0	5.5	1.9
F033540019206	1	6.0	1.4	6.5	1.1	7.0	.4	7.5	.6	8.0	22.6
F033540019207	1	8.5	33.6	9.0	53.1	9.5	26.7	10.0	14.6	10.5	9.5
F033540019208	1	11.0	7.3	11.5	5.3	12.0	5.2	12.5	7.0	13.0	6.1
F033540019209	1	14.0	4.5	15.0	4.6	16.0	3.0	17.0	2.4	18.0	2.0
F033540019210	1	19.0	2.3	20.0	2.1	21.0	39.9	22.0	28.9	23.0	20.4
F033540019211	1	24.0	18.1	25.0	15.0	27.0	11.9	29.0	10.6		

TABLE VI-6. FS 30-P-0.5-E-6

F033540025001											
F033540025101											
F033540025102											
F033540025103											
F033540025104											
F033540027001											
F033540027002											
F033540027004						760.					
F033540029001	1		001001	.3	29.0	54				18.	
F033540029201	1	.3	41.8	.4	91.1	.5	92.3	.6	95.1	.7	95.4
F033540029202	1	.8	95.1	.9	96.0	1.0	96.0	1.1	95.3	1.2	95.4
F033540029203	1	1.3	96.0	1.4	96.8	1.5	96.2	1.6	96.0	1.7	96.2
F033540029204	1	1.8	96.8	1.9	97.0	2.0	96.0	2.5	91.8	3.0	72.4
F033540029205	1	3.5	86.4	4.0	83.0	4.5	66.6	5.0	5.2	5.5	4.3
F033540029206	1	6.0	3.7	6.5	3.8	7.0	2.4	7.5	2.2	8.0	23.6
F033540029207	1	8.5	31.5	9.0	51.5	9.5	25.8	10.0	16.5	10.5	11.2
F033540029208	1	11.0	8.5	11.5	6.7	12.0	6.7	12.5	8.3	13.0	7.6
F033540029209	1	14.0	6.1	15.0	5.4	16.0	5.1	17.0	4.3	18.0	4.4
F033540029210	1	19.0	4.0	20.0	15.8	21.0	35.9	22.0	27.5	23.0	21.0
F033540029211	1	24.0	18.5	25.0	15.1	27.0	13.2	29.0	13.3		

TABLE VI-7. SECOND SURFACE SILVER COATED DIFFUSE TEFLON

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F0335! 015001              1      001
F033550015101          SECOND SURFACE SILVER COATED DIFFUSE TEFLON, TEFLON/SILVER
F033550015102          TEFLON PRESSED BETWEEN ROUGHENED          FIRST SURFACE
F033550015103          QUARTZ 3 M ROUGHENED, SECOND SURFACE QUARTZ 9 M, BOTH QUARTZ
F033550015104          .83 HOURS HF ETCH, SOLAR ABS.=.0996              NORMAL
F033550017001          010175                                                   300.
F033550017002
F033550017004                                  760.
F033550019001    1          001001   .3   29.0   54                     18.
F033550019201    1    .3    13.0   .4    78.3   .5   89.5   .6   93.0   .7   94.7
F033550019202    1    .8    95.2   .9    96.5  1.0   97.1  1.1   97.0  1.2   94.7
F033550019203    1   1.3    97.9  1.4    97.0  1.5   97.5  1.6   97.5  1.7   97.0
F033550019204    1   1.8    98.1  1.9    98.0  2.0   98.0  2.5   94.3  3.0   92.9
F033550019205    1   3.5    90.9  4.0    41.0  4.5   70.2  5.0   68.3  5.5   36.7
F033550019206    1   6.0    52.5  6.5    26.7  7.0   19.3  7.5    2.0  8.0    4.9
F033550019207    1   8.5     4.3  9.0     5.7  9.5   10.9 10.0    4.1 10.5    7.6
F033550019208    1  11.0    12.2 11.5     7.0 12.0    5.1 12.5    3.4 13.0    2.4
F033550019209    1  14.0     2.3 15.0     1.7 16.0    2.7 17.0    2.9 18.0    2.2
F033550019210    1  19.0     3.4 20.0     7.2 21.0    5.4 22.0    9.9 23.0   25.2
F033550019211    1  24.0    31.7 25.0    34.3 27.0   41.8 29.0   37.2
```

TABLE VI-8 SECOND SURFACE SILVER COATED DIFFUSE TEFLON

```
F033550025001              1      001
F033550025101          SECOND SURFACE SILVER COATED DIFFUSE TEFLON, TEFLON/SILVER,
F033550025102          TEFLON PRESSED BETWEEN ROUGHENED          FIRST SURFACE
F033550025103          QUARTZ 3 M ROUGHENED, SECOND SURFACE QUARTZ 9 M, BOTH QUARTZ
F033550025104          .83 HOURS HF ETCH, SOLAR ABS.=.1070              NORMAL
F033550027001          010175                                                   300.
F033550027002
F033550027004                                  760.
F033550029001    1          001001   .3   29.0   54                     18.
F033550029201    1    .3    12.9   .4    75.5   .5   88.7   .6   94.0   .7   95.0
F033550029202    1    .8    95.4   .9    95.7  1.0   96.8  1.1   96.2  1.2   96.5
F033550029203    1   1.3    96.9  1.4    96.8  1.5   97.4  1.6   97.0  1.7   97.6
F033550029204    1   1.8    97.0  1.9    97.0  2.0   97.0  2.5   92.6  3.0   90.7
F033550029205    1   3.5    89.1  4.0    37.9  4.5   67.8  5.0   66.3  5.5   33.2
F033550029206    1   6.0    49.0  6.5    24.0  7.0   17.1  7.5    1.6  8.0    4.4
F033550029207    1   8.5     4.3  9.0     5.7  9.5    8.4 10.0    4.3 10.5    4.8
F033550029208    1  11.0    10.5 11.5     4.9 12.0    3.3 12.5    2.7 13.0    2.9
F033550029209    1  14.0     2.0 15.0     1.7 16.0    2.9 17.0    2.7 18.0    2.1
F033550029210    1  19.0     3.6 20.0     7.4 21.0    5.4 22.0   10.4 23.0   21.1
F033550029211    1  24.0    25.6 25.0    33.3 27.0   35.0 29.0   40.9
```

ANNEX VII

DIRECTIONAL-HEMISPHERICAL REFLECTANCE, AND DIRECTIONAL EMITTANCE 2.5 TO 30 μm AND 200 TO 700°K

This table presents the directional (near normal) hemispherical reflectance as a function of wavelength (column headed RHO) and the directional (near normal) emittance as a function of wavelength (column headed E), and the near-normal emittance as a function of temperature from 200 to 700°K.

TABLE VII-1
REFLECTANCE 2.5 TO 30 μ

LAMBDA	FS 3-9 1.5 N-4 SAMPLE RHO	FS 3-9 1.5 N-4 E	FS 3-9 2.5 N-4 SAMPLE RHO	FS 3-9 2.5 N-4 E	FS 3-9 3.5 N-4 SAMPLE RHO	FS 3-9 3.5 N-4 E
2.50	.9339	.0661	.9410	.0590	.9164	.0836
3.00	.9184	.0816	.9257	.0743	.8913	.1087
3.50	.9212	.0788	.9296	.0704	.9044	.0956
4.00	.8447	.1553	.8611	.1389	.8232	.1768
4.50	.6207	.3793	.6467	.3533	.6068	.3932
5.00	.0236	.9764	.0247	.9753	.0205	.9795
5.50	.0207	.9793	.0207	.9793	.0186	.9814
6.00	.0167	.9833	.0157	.9843	.0136	.9864
6.50	.0102	.9898	.0112	.9888	.0112	.9888
7.00	.0052	.9948	.0052	.9948	.0041	.9959
7.50	.0052	.9948	.0021	.9979	.0062	.9938
8.00	.1940	.8050	.1901	.8099	.2257	.7743
8.50	.3975	.6025	.3945	.6055	.3362	.6638
9.00	.6477	.3523	.6457	.3543	.5313	.4687
9.50	.3330	.6670	.3310	.6690	.2674	.7326
10.00	.2078	.7922	.1819	.8181	.1455	.8545
10.50	.1169	.8831	.1189	.8811	.0949	.9051
11.00	.0926	.9074	.0916	.9084	.0727	.9273
11.50	.0651	.9349	.0651	.9349	.0531	.9469
12.00	.0629	.9371	.0609	.9391	.0516	.9484
12.50	.0885	.9115	.0864	.9135	.0704	.9296
13.00	.0740	.9260	.0740	.9260	.0607	.9393
14.00	.0591	.9409	.0581	.9419	.0448	.9552
15.00	.0423	.9577	.0453	.9547	.0463	.9537
16.00	.0417	.9583	.0417	.9583	.0298	.9702
17.00	.0252	.9748	.0273	.9727	.0242	.9758
18.00	.0194	.9806	.0214	.9786	.0204	.9796
19.00	.0257	.9743	.0329	.9671	.0226	.9774
20.00	.2566	.7434	.2620	.7380	.2070	.7930
21.00	.5400	.4600	.5446	.4554	.3987	.6013
22.00	.3838	.6162	.3689	.6311	.2891	.7109
23.00	.2602	.7398	.2703	.7297	.2035	.7965
24.00	.2435	.7565	.2355	.7645	.1806	.8194
25.00	.1940	.8060	.1950	.8050	.1505	.8495
26.00	.1645	.8355	.1706	.8294	.1351	.8649
27.00	.1532	.8468	.1584	.8416	.1186	.8814
28.00	.1523	.8477	.1533	.8467	.0985	.9015
29.00	.1552	.8448	.1500	.8500	.1056	.8944
30.00	.1344	.8656	.1427	.8573	.0992	.9008

```
LAMBDA MAX FOR  200 DEG. K IS   14.4890  MICRONS
FOR  TEMP=   200 THE PART OF BLACKBODY ENERGY BELOW   2.50 IS  .0000, ABOVE  30.00 IS  .2523     MISSING ENERGY= .2523
TOTAL DIRECTIONAL EMITTANCE AT THETA=  18.00              TEMPERATURE=   200 DEG. K  EQUALS
   .8453 FOR SAMPLE      4,     .8450 FOR SAMPLE      1,    .8785 FOR SAMPLE      2,

LAMBDA MAX FOR  250 DEG. K IS   11.5912  MICRONS
FOR  TEMP=   250 THE PART OF BLACKBODY ENERGY BELOW   2.50 IS  .0000, ABOVE  30.00 IS  .1656     MISSING ENERGY= .1656
TOTAL DIRECTIONAL EMITTANCE AT THETA=  18.00              TEMPERATURE=   250 DEG. K  EQUALS
   .8473 FOR SAMPLE      4,     .8477 FOR SAMPLE      1,    .8776 FOR SAMPLE      2,

LAMBDA MAX FOR  300 DEG. K IS    9.6593  MICRONS
FOR  TEMP=   300 THE PART OF BLACKBODY ENERGY BELOW   2.50 IS  .0000, ABOVE  30.00 IS  .1100     MISSING ENERGY= .1100
TOTAL DIRECTIONAL EMITTANCE AT THETA=  18.00              TEMPERATURE=   300 DEG. K  EQUALS
   .8453 FOR SAMPLE      4,     .8461 FOR SAMPLE      1,    .8732 FOR SAMPLE      2,

LAMBDA MAX FOR  350 DEG. K IS    8.2794  MICRONS
FOR  TEMP=   350 THE PART OF BLACKBODY ENERGY BELOW   2.50 IS  .0001, ABOVE  30.00 IS  .0763     MISSING ENERGY= .0764
TOTAL DIRECTIONAL EMITTANCE AT THETA=  18.00              TEMPERATURE=   350 DEG. K  EQUALS
   .8392 FOR SAMPLE      4,     .8399 FOR SAMPLE      1,    .8648 FOR SAMPLE      2,

LAMBDA MAX FOR  400 DEG. K IS    7.2445  MICRONS
FOR  TEMP=   400 THE PART OF BLACKBODY ENERGY BELOW   2.50 IS  .0003, ABOVE  30.00 IS  .0549     MISSING ENERGY= .0553
TOTAL DIRECTIONAL EMITTANCE AT THETA=  18.00              TEMPERATURE=   400 DEG. K  EQUALS
   .8273 FOR SAMPLE      4,     .8272 FOR SAMPLE      1,    .8505 FOR SAMPLE      2,

LAMBDA MAX FOR  450 DEG. K IS    6.4396  MICRONS
FOR  TEMP=   450 THE PART OF BLACKBODY ENERGY BELOW   2.50 IS  .0011, ABOVE  30.00 IS  .0408     MISSING ENERGY= .0419
TOTAL DIRECTIONAL EMITTANCE AT THETA=  18.00              TEMPERATURE=   450 DEG. K  EQUALS
   .8079 FOR SAMPLE      4,     .8075 FOR SAMPLE      1,    .8297 FOR SAMPLE      2,

LAMBDA MAX FOR  500 DEG. K IS    5.7956  MICRONS
FOR  TEMP=   500 THE PART OF BLACKBODY ENERGY BELOW   2.50 IS  .0031, ABOVE  30.00 IS  .0311     MISSING ENERGY= .0342
TOTAL DIRECTIONAL EMITTANCE AT THETA=  18.00              TEMPERATURE=   500 DEG. K  EQUALS
   .7828 FOR SAMPLE      4,     .7817 FOR SAMPLE      1,    .8031 FOR SAMPLE      2,

LAMBDA MAX FOR  550 DEG. K IS    5.2687  MICRONS
FOR  TEMP=   550 THE PART OF BLACKBODY ENERGY BELOW   2.50 IS  .0068, ABOVE  30.00 IS  .0242     MISSING ENERGY= .0310
TOTAL DIRECTIONAL EMITTANCE AT THETA=  18.00              TEMPERATURE=   550 DEG. K  EQUALS
   .7534 FOR SAMPLE      4,     .7515 FOR SAMPLE      1,    .7726 FOR SAMPLE      2,

LAMBDA MAX FOR  600 DEG. K IS    4.8297  MICRONS
FOR  TEMP=   600 THE PART OF BLACKBODY ENERGY BELOW   2.50 IS  .0128, ABOVE  30.00 IS  .0192     MISSING ENERGY= .0323
TOTAL DIRECTIONAL EMITTANCE AT THETA=  18.00              TEMPERATURE=   600 DEG. K  EQUALS
   .7216 FOR SAMPLE      4,     .7190 FOR SAMPLE      1,    .7401 FOR SAMPLE      2,

LAMBDA MAX FOR  650 DEG. K IS    4.4582  MICRONS
FOR  TEMP=   650 THE PART OF BLACKBODY ENERGY BELOW   2.50 IS  .0217, ABOVE  30.00 IS  .0155     MISSING ENERGY= .0372
TOTAL DIRECTIONAL EMITTANCE AT THETA=  18.00              TEMPERATURE=   650 DEG. K  EQUALS
   .6892 FOR SAMPLE      4,     .6859 FOR SAMPLE      1,    .7071 FOR SAMPLE      2,

LAMBDA MAX FOR  700 DEG. K IS    4.1397  MICRONS
FOR  TEMP=   700 THE PART OF BLACKBODY ENERGY BELOW   2.50 IS  .0337, ABOVE  30.00 IS  .0127     MISSING ENERGY= .0463
TOTAL DIRECTIONAL EMITTANCE AT THETA=  18.00              TEMPERATURE=   700 DEG. K  EQUALS
   .6574 FOR SAMPLE      4,     .6535 FOR SAMPLE      1,    .6749 FOR SAMPLE      2,
```

TABLE VII-2. (SAMPLE IDENTIFICATION AS IN TABLE VII-1)
EMITTANCE 200° TO 700°K

TABLE VII-3
REFLECTANCE 2.5 to 30 um

LAMBDA	FS 3-9 1.5 E6 SAMPLE RHO	E	FS 3-9 2.5 E SAMPLE RHO	E	FS 30-P.5 E6 SAMPLE RHO	E
2.50	.9167	.0833	.9402	.0598	.9177	.0823
3.00	.7437	.2563	.7838	.2162	.7242	.2758
3.50	.8646	.1354	.8982	.1018	.8635	.1365
4.00	.8243	.1757	.8668	.1332	.8295	.1705
4.50	.6258	.3742	.6915	.3085	.6656	.3344
5.00	.0428	.9572	.0512	.9488	.0522	.9478
5.50	.0394	.9606	.0425	.9575	.0436	.9564
6.00	.0321	.9679	.0373	.9627	.0373	.9627
6.50	.0306	.9694	.0327	.9673	.0378	.9622
7.00	.0235	.9765	.0276	.9724	.0235	.9765
7.50	.0240	.9760	.0260	.9740	.0220	.9780
8.00	.2386	.7614	.2355	.7645	.2355	.7645
8.50	.3950	.6050	.3991	.6009	.3148	6852
9.00	.6392	.3608	.6473	.3527	.5148	.4852
9.50	.3381	.6619	.3361	.6639	.2676	.7324
10.00	.1939	.8061	.1950	.8050	.1652	.8348
10.50	.1327	.8673	.1368	.8632	.1123	.8877
11.00	.1098	.8902	.1088	.8912	.0854	.9146
11.50	.0792	.9208	.0812	.9188	.0670	.9330
12.00	.0793	.9207	.0793	.9207	.0668	9332
12.50	.1015	.8985	.1015	.8985	.0829	.9171
13.00	.0956	.9044	.0946	.9054	.0761	.9239
14.00	.0732	.9268	.0722	.9278	.0610	.9390
15.00	.0639	.9361	.0682	.9318	.0541	.9459
16.00	.0582	.9418	.0602	.9398	.0512	.9488
17.00	.0482	.9518	.0525	.9475	.0428	.9572
18.00	.0436	.9564	.0397	.9603	.0436	.9564
19.00	.0444	.9556	.0444	.9556	.0402	.9598
20.00	.2593	.7407	.2665	.7335	.1877	.8123
21.00	.5219	.4781	.5307	.4693	.3593	.6407
22.00	.3903	.6097	.3799	.6202	.2753	.7247
23.00	.2986	.7014	.2931	.7069	.2100	.7900
24.00	.2385	.7615	.2464	.7536	.1851	.8149
25.00	.2124	.7876	.2113	.7887	.1508	.8492
26.00	.1978	.8022	.1825	.8175	.1322	.8678
27.00	.1839	.8161	.1717	.8283	.1318	.8682
28.00	.1698	.8302	.1776	.8224	.1324	.8676
29.00	.1653	.8347	.1573	.8427	.1333	.8667
30.00	.1718	.8282	.1652	.8348	.1276	.8724

```
LAMBDA MAX FOR  200 DEG. K IS   14.4899  MICRONS
FOR  TEMP=   200 THE PART OF BLACKBODY ENERGY BELOW   2.50 IS  .0000, ABOVE  30.00 IS  .2623     MISSING ENERGY= .2623
TOTAL DIRECTIONAL EMITTANCE AT THETA=  18.00              TEMPERATURE=   200 DEG. K  EQUALS
   .8303 FOR SAMPLE      4,    .8302 FOR SAMPLE      1,    .8702 FOR SAMPLE      2,

LAMBDA MAX FOR  250 DEG. K IS   11.5912  MICRONS
FOR  TEMP=   250 THE PART OF BLACKBODY ENERGY BELOW   2.50 IS  .0000, ABOVE  30.00 IS  .1655     MISSING ENERGY= .1656
TOTAL DIRECTIONAL EMITTANCE AT THETA=  18.00              TEMPERATURE=   250 DEG. K  EQUALS
   .8329 FOR SAMPLE      4,    .8322 FOR SAMPLE      1,    .8685 FOR SAMPLE      2,

LAMBDA MAX FOR  300 DEG. K IS    9.6593  MICRONS
FOR  TEMP=   300 THE PART OF BLACKBODY ENERGY BELOW   2.50 IS  .0000, ABOVE  30.00 IS  .1100     MISSING ENERGY= .1100
TOTAL DIRECTIONAL EMITTANCE AT THETA=  18.00              TEMPERATURE=   300 DEG. K  EQUALS
   .8317 FOR SAMPLE      4,    .8297 FOR SAMPLE      1,    .8633 FOR SAMPLE      2,

LAMBDA MAX FOR  350 DEG. K IS    8.2794  MICRONS
FOR  TEMP=   350 THE PART OF BLACKBODY ENERGY BELOW   2.50 IS  .0001, ABOVE  30.00 IS  .0763     MISSING ENERGY= .0764
TOTAL DIRECTIONAL EMITTANCE AT THETA=  18.00              TEMPERATURE=   350 DEG. K  EQUALS
   .8257 FOR SAMPLE      4,    .8229 FOR SAMPLE      1,    .8540 FOR SAMPLE      2,

LAMBDA MAX FOR  400 DEG. K IS    7.2445  MICRONS
FOR  TEMP=   400 THE PART OF BLACKBODY ENERGY BELOW   2.50 IS  .0003, ABOVE  30.00 IS  .0549     MISSING ENERGY= .0553
TOTAL DIRECTIONAL EMITTANCE AT THETA=  18.00              TEMPERATURE=   400 DEG. K  EQUALS
   .8145 FOR SAMPLE      4,    .8101 FOR SAMPLE      1,    .8390 FOR SAMPLE      2,

LAMBDA MAX FOR  450 DEG. K IS    6.4396  MICRONS
FOR  TEMP=   450 THE PART OF BLACKBODY ENERGY BELOW   2.50 IS  .0011, ABOVE  30.00 IS  .0408     MISSING ENERGY= .0419
TOTAL DIRECTIONAL EMITTANCE AT THETA=  18.00              TEMPERATURE=   450 DEG. K  EQUALS
   .7973 FOR SAMPLE      4,    .7909 FOR SAMPLE      1,    .8181 FOR SAMPLE      2,

LAMBDA MAX FOR  500 DEG. K IS    5.7956  MICRONS
FOR  TEMP=   500 THE PART OF BLACKBODY ENERGY BELOW   2.50 IS  .0031, ABOVE  30.00 IS  .0311     MISSING ENERGY= .0342
TOTAL DIRECTIONAL EMITTANCE AT THETA=  18.00              TEMPERATURE=   500 DEG. K  EQUALS
   .7747 FOR SAMPLE      4,    .7662 FOR SAMPLE      1,    .7923 FOR SAMPLE      2,

LAMBDA MAX FOR  550 DEG. K IS    5.2687  MICRONS
FOR  TEMP=   550 THE PART OF BLACKBODY ENERGY BELOW   2.50 IS  .0068, ABOVE  30.00 IS  .0242     MISSING ENERGY= .0310
TOTAL DIRECTIONAL EMITTANCE AT THETA=  18.00              TEMPERATURE=   550 DEG. K  EQUALS
   .7495 FOR SAMPLE      4,    .7378 FOR SAMPLE      1,    .7632 FOR SAMPLE      2,

LAMBDA MAX FOR  600 DEG. K IS    4.8297  MICRONS
FOR  TEMP=   600 THE PART OF BLACKBODY ENERGY BELOW   2.50 IS  .0128, ABOVE  30.00 IS  .0192     MISSING ENERGY= .0320
TOTAL DIRECTIONAL EMITTANCE AT THETA=  18.00              TEMPERATURE=   600 DEG. K  EQUALS
   .7203 FOR SAMPLE      4,    .7076 FOR SAMPLE      1,    .7327 FOR SAMPLE      2,

LAMBDA MAX FOR  650 DEG. K IS    4.4582  MICRONS
FOR  TEMP=   650 THE PART OF BLACKBODY ENERGY BELOW   2.50 IS  .0217, ABOVE  30.00 IS  .0155     MISSING ENERGY= .0372
TOTAL DIRECTIONAL EMITTANCE AT THETA=  18.00              TEMPERATURE=   650 DEG. K  EQUALS
   .6917 FOR SAMPLE      4,    .6771 FOR SAMPLE      1,    .7021 FOR SAMPLE      2,

LAMBDA MAX FOR  700 DEG. K IS    4.1397  MICRONS
FOR  TEMP=   700 THE PART OF BLACKBODY ENERGY BELOW   2.50 IS  .0337, ABOVE  30.00 IS  .0127     MISSING ENERGY= .0463
TOTAL DIRECTIONAL EMITTANCE AT THETA=  18.00              TEMPERATURE=   700 DEG. K  EQUALS
   .6639 FOR SAMPLE      4,    .6474 FOR SAMPLE      1,    .6726 FOR SAMPLE      2,
```

TABLE VII-4. (SAMPLE IDENTIFICATION AS IN TABLE VII-3).
EMITTANCE 200° to 700°K

TABLE VII-5
REFLECTANCE 2.5 TO 30 um

LAMBDA				
2.50	[illegible]	[illegible]	[illegible]	[illegible]
3.00	[illegible]	[illegible]	[illegible]	.0927
3.50	[illegible]	[illegible]	[illegible]	.1092
4.00	.4095	[illegible]	.3793	.6207
4.50	.7022	.2978	.6776	.3224
5.00	.6833	.3167	.6628	.3372
5.50	.3666	.6334	.3317	.6683
6.00	.5254	.4746	.4900	.5100
6.50	.2670	.7330	.2399	.7601
7.00	.1931	.8069	.1714	.8286
7.50	.0203	.9797	.0164	[illegible]
8.00	.0490	.9510	.0445	.9555
8.50	.0429	.9571	.0432	.9568
9.00	.0569	.9431	.0569	.9431
9.50	.1089	.8911	.0835	.9165
10.00	.0413	.9587	.0426	.9574
10.50	.0764	.9236	.0478	.9522
11.00	.1222	.8778	.1053	.8947
11.50	.0697	.9303	.0488	.9512
12.00	.0509	.9491	.0328	.9672
12.50	.0345	.9655	.0266	.9734
13.00	.0241	.9759	.0290	.9710
14.00	.0232	.9768	.0203	.9797
15.00	.0167	.9833	.0172	.9828
16.00	.0272	.9728	.0286	.9714
17.00	.0288	.9712	.0266	.9734
18.00	.0221	.9779	.0206	.9794
19.00	.0343	.9657	.0358	.9642
20.00	.0718	.9282	.0736	.9264
21.00	.0536	.9464	.0538	.9462
22.00	.0990	.9010	.1044	.8956
23.00	.2517	.7483	.2112	.7888
24.00	.3171	.6829	.2559	.7441
25.00	.3432	.6568	.3333	.6667
26.00	.2529	.7472	.2579	.7421
27.00	.4175	.5825	.3500	.6500
28.00	.4491	.5509	.3473	.6527
29.00	.3717	.6283	.4086	.5914
30.00	.3822	.6178	.2602	.7398
32.00	.2981	.7019	.1791	.8209
34.00	.2499	.7501	.1588	.8412
36.00	.2790	.7210	.2325	.7675
38.00	.3488	.6512	.3710	.6290
39.00	.4256	.5744	.4139	.5861

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LAMBDA MAX FOR  200 DEG. K IS    14.4890  MICRONS
FOR  TEMP=   200 THE PART OF BLACKBODY ENERGY BELOW    2.50 IS  .0000, ABOVE  39.00 IS  .1520      MISSING ENERGY= .1520
TOTAL DIRECTIONAL EMITTANCE AT THETA=  18.00             TEMPERATURE=   200 DEG. K  EQUALS
   .8574 FOR SAMPLE      4,                                .8780 FOR SAMPLE     2,

LAMBDA MAX FOR  250 DEG. K IS    11.5912  MICRONS
FOR  TEMP=   250 THE PART OF BLACKBODY ENERGY BELOW    2.50 IS  .0000, ABOVE  39.00 IS  .0912      MISSING ENERGY= .0912
TOTAL DIRECTIONAL EMITTANCE AT THETA=  18.00             TEMPERATURE=   250 DEG. K  EQUALS
   .8765 FOR SAMPLE      4,                                .8932 FOR SAMPLE     2,

LAMBDA MAX FOR  300 DEG. K IS     9.6593  MICRONS
FOR  TEMP=   300 THE PART OF BLACKBODY ENERGY BELOW    2.50 IS  .0000, ABOVE  39.00 IS  .0585      MISSING ENERGY= .0585
TOTAL DIRECTIONAL EMITTANCE AT THETA=  18.00             TEMPERATURE=   300 DEG. K  EQUALS
   .8739 FOR SAMPLE      4,                                .8892 FOR SAMPLE     2,

LAMBDA MAX FOR  350 DEG. K IS     8.2794  MICRONS
FOR  TEMP=   350 THE PART OF BLACKBODY ENERGY BELOW    2.50 IS  .0001, ABOVE  39.00 IS  .0395      MISSING ENERGY= .0397
TOTAL DIRECTIONAL EMITTANCE AT THETA=  18.00             TEMPERATURE=   350 DEG. K  EQUALS
   .8552 FOR SAMPLE      4,                                .8703 FOR SAMPLE     2,

LAMBDA MAX FOR  400 DEG. K IS     7.2445  MICRONS
FOR  TEMP=   400 THE PART OF BLACKBODY ENERGY BELOW    2.50 IS  .0003, ABOVE  39.00 IS  .0280      MISSING ENERGY= .0284
TOTAL DIRECTIONAL EMITTANCE AT THETA=  18.00             TEMPERATURE=   400 DEG. K  EQUALS
   .8256 FOR SAMPLE      4,                                .8412 FOR SAMPLE     2,
```

TABLE VII-6. (SAMPLE IDENTIFICATION AS IN TABLE VII-5
EMITTANCE 200 TO 400^{o}K

ANNEX VIII

DIRECTIONAL-HEMISPHERICAL REFLECTANCE
(U.V., VIS, NEAR I.R.)

This annex provides a graphical presentation of the directional-hemispherical reflectance from 0.28 to 29 μm.

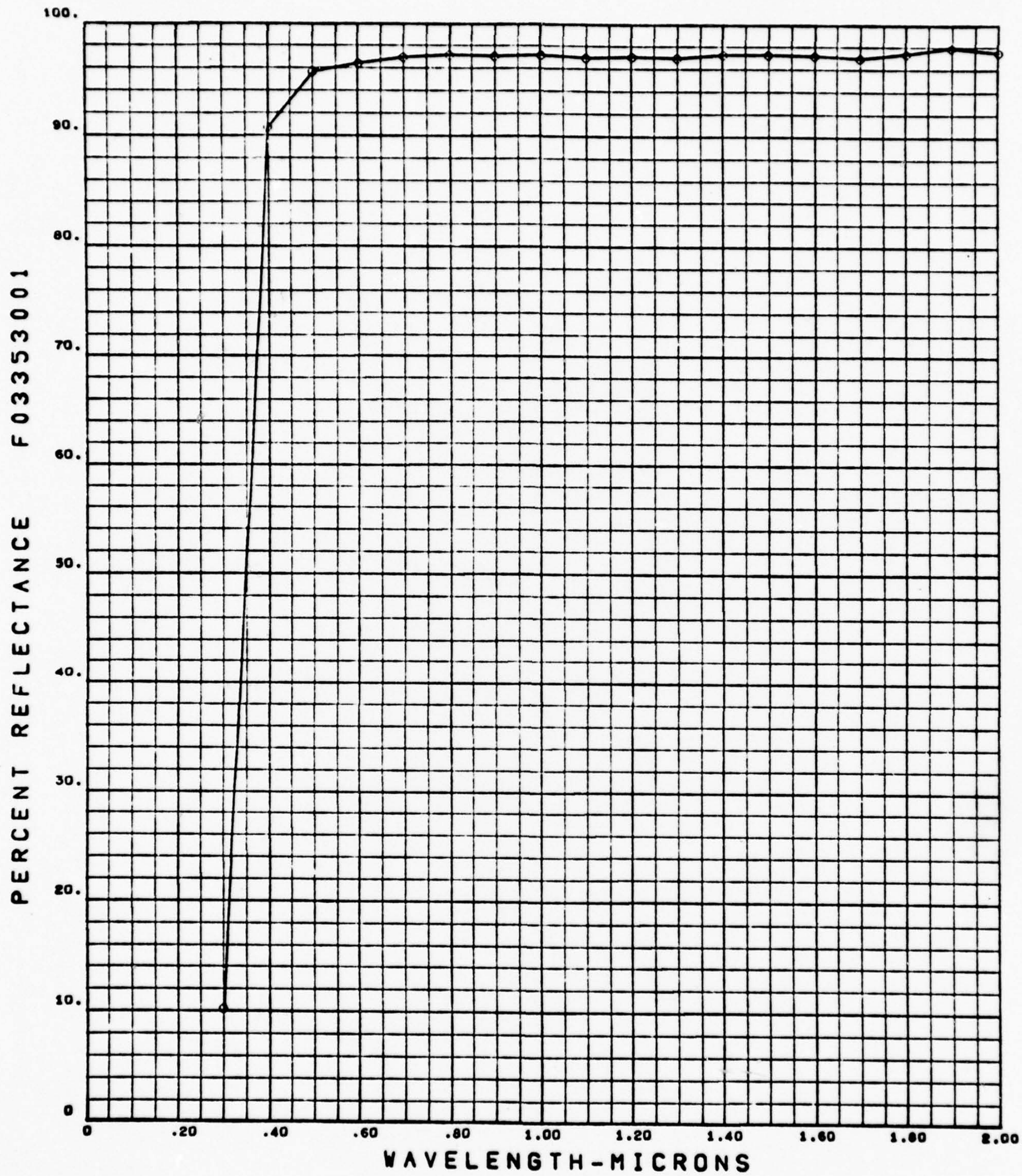

FIGURE VIII-1. DIRECTIONAL-HEMISPHERICAL REFLECTANCE (U.V., VIS., NEAR I.R.)

FUSED SILICA GROUND FRONT 3 MICRON GRIT, BACK 9 MICRON GRIT, 1.5 HOURS HF ETCH, NON-ENHANCED SILVER

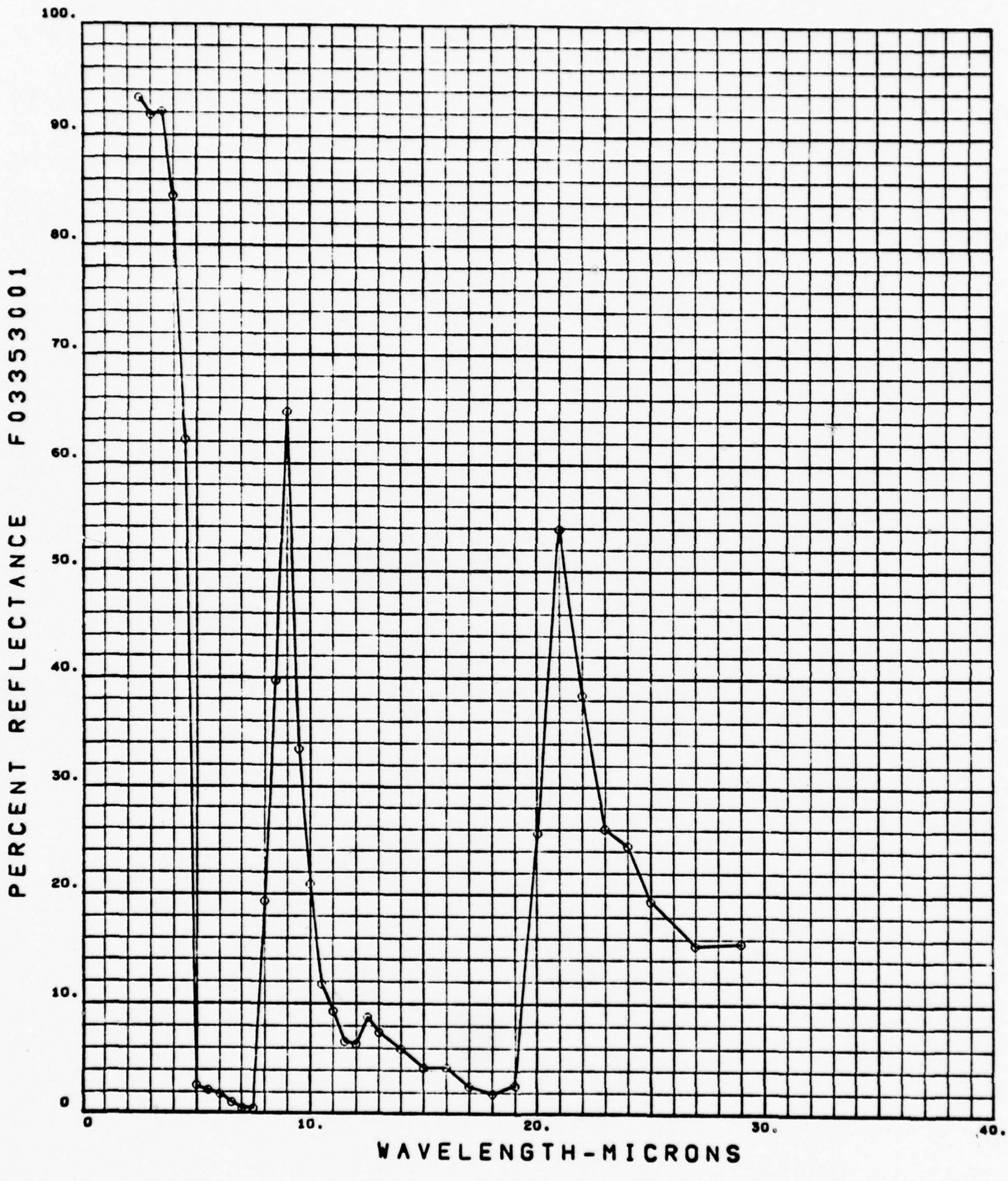

FIGURE VIII-2. DIRECTIONAL-HEMISPHERICAL REFLECTANCE (I.R.)

FUSED SILICA GROUND FRONT 3 MICRON GRIT, BACK 9 MICRON GRIT, 1.5 HOURS HF ETCH, NON-ENHANCED SILVER

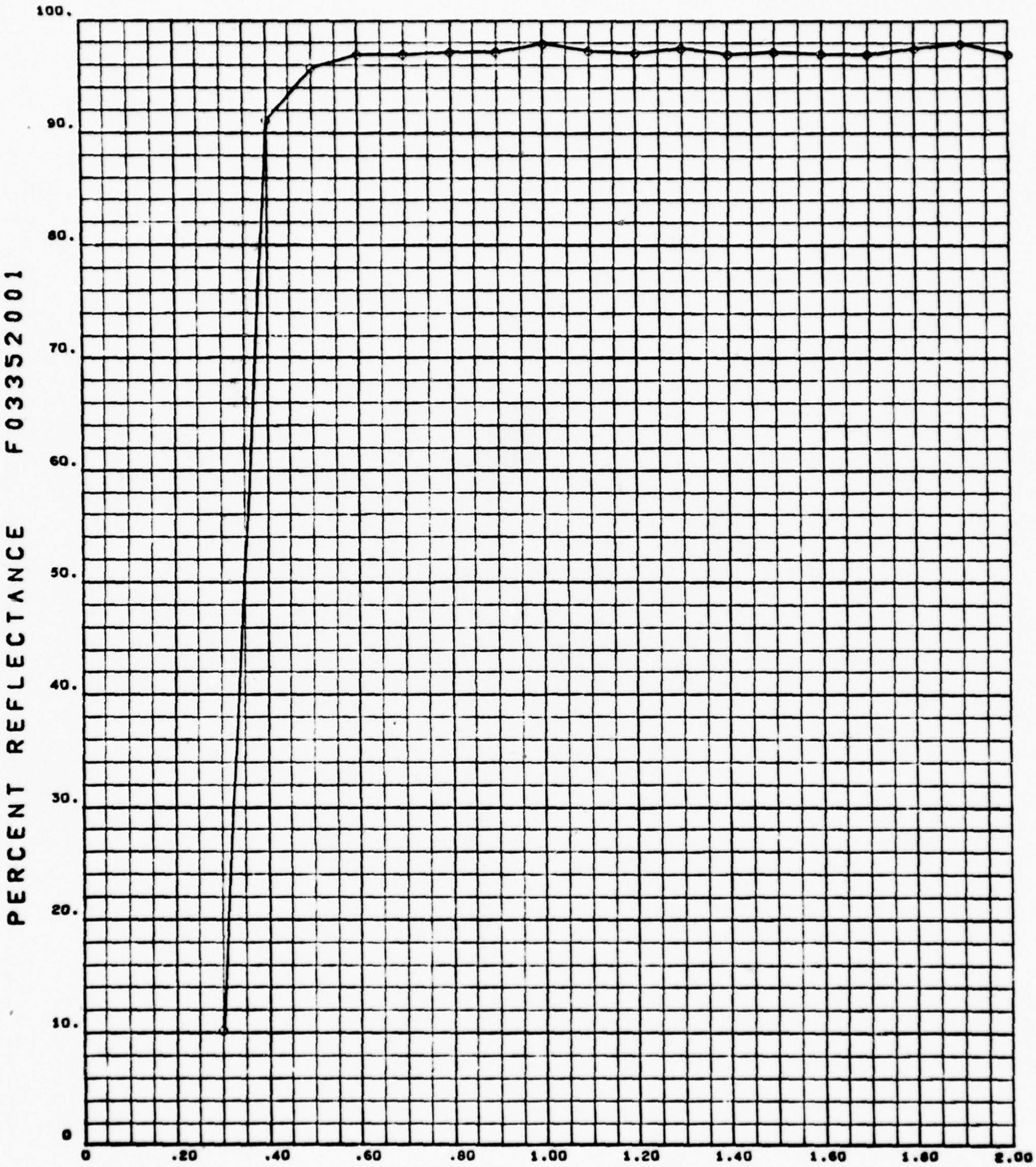

FIGURE VIII-3. DIRECTIONAL-HEMISPHERICAL REFLECTANCE (U.V., VIS., NEAR I.R.)

FUSED SILICA GROUND FRONT 3 MICRON GRIT, BACK 9 MICRON GRIT, 2.5 HOURS HF ETCH, NON-ENHANCED SILVER

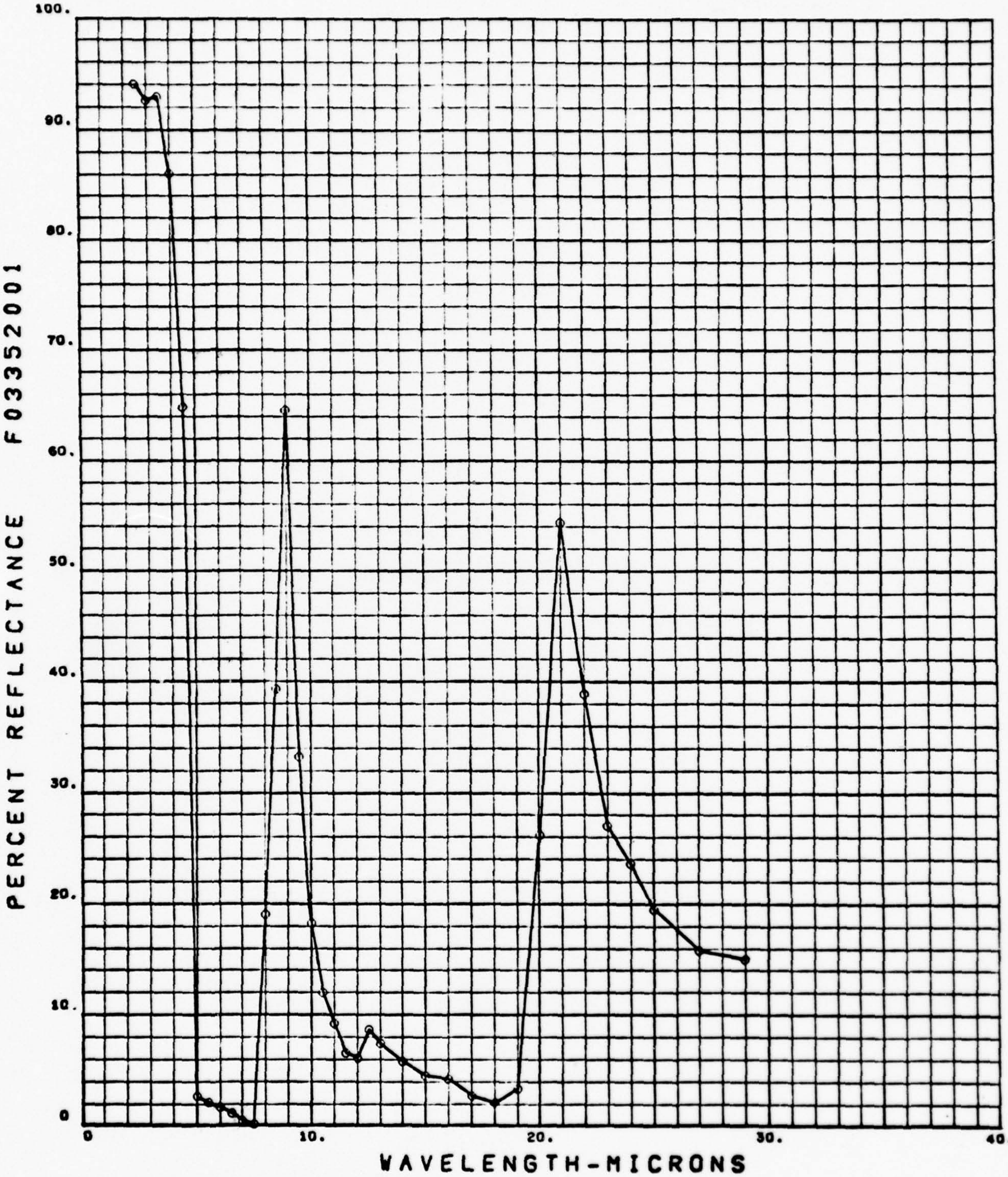

FIGURE VIII-4. DIRECTIONAL-HEMISPHERICAL REFLECTANCE (I.R.)

FUSED SILICA GROUND FRONT 3 MICRON GRIT, BACK 9 MICRON GRIT, 2.5 HOURS HF ETCH, NON-ENHANCED SILVER

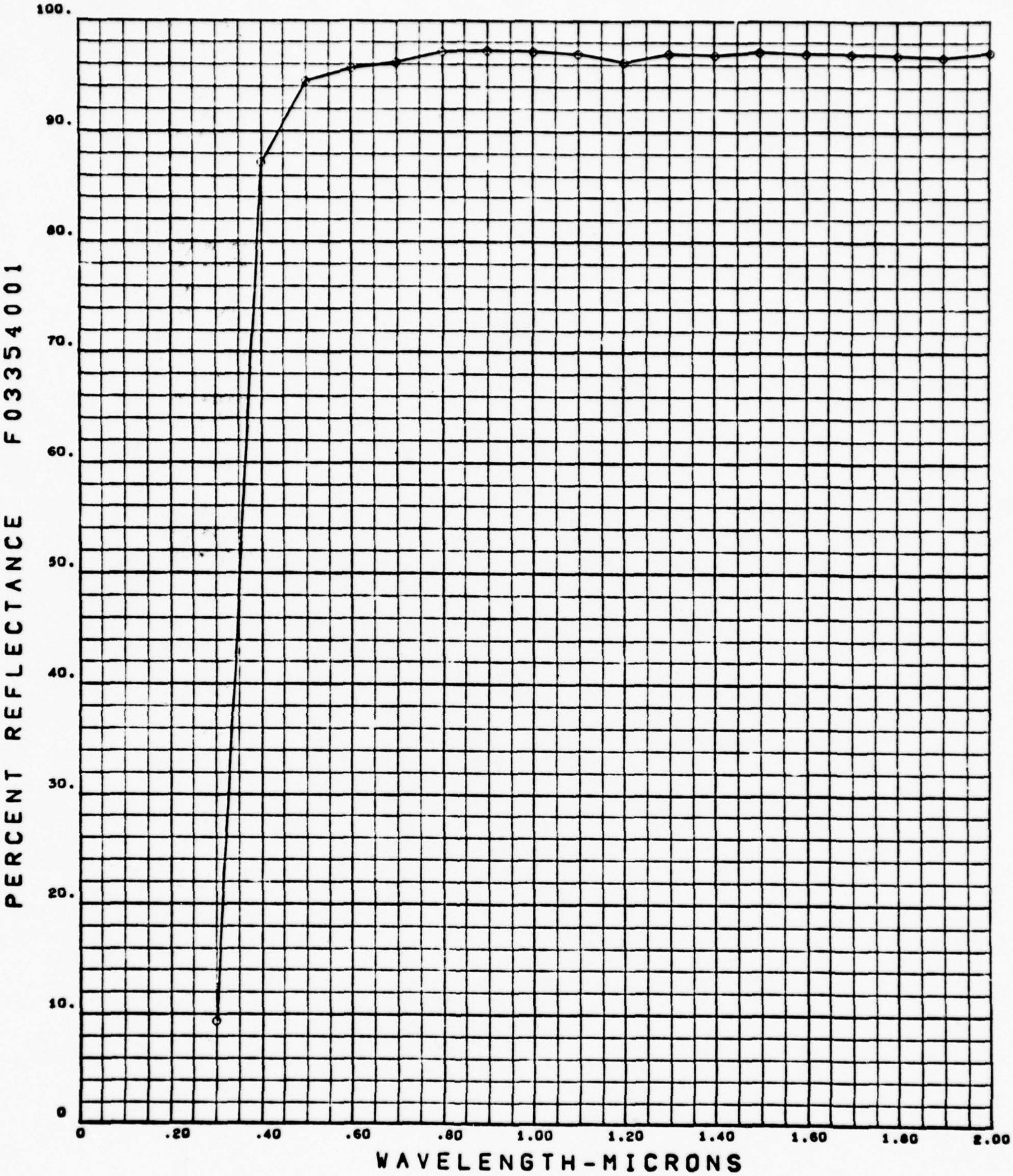

FIGURE VIII-5. DIRECTIONAL-HEMISPHERICAL REFLECTANCE
(U.V., VIS., NEAR I.R.)

FUSED SILICA GROUND FRONT 30 MICRON GRIT,
BACK POLISHED, 0.5 HOURS HF ETCH, NONENHANCED SILVER

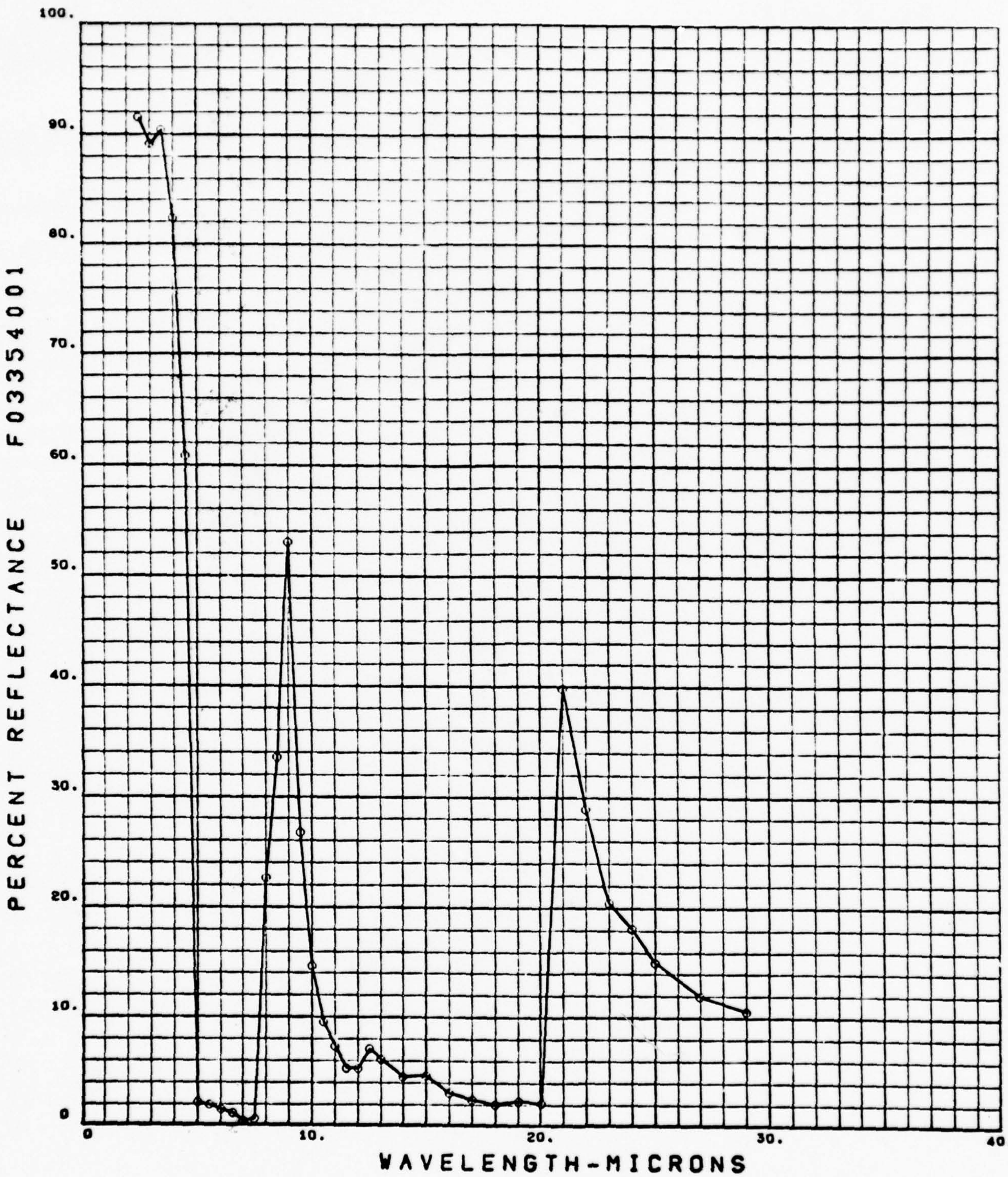

FIGURE VIII-6. DIRECTIONAL-HEMISPHERICAL REFLECTANCE (I.R.)

FUSED SILICA GROUND FRONT 30 MICRON GRIT, BACK POLISHED, 0.5 HOURS HF ETCH, NONENHANCED SILVER

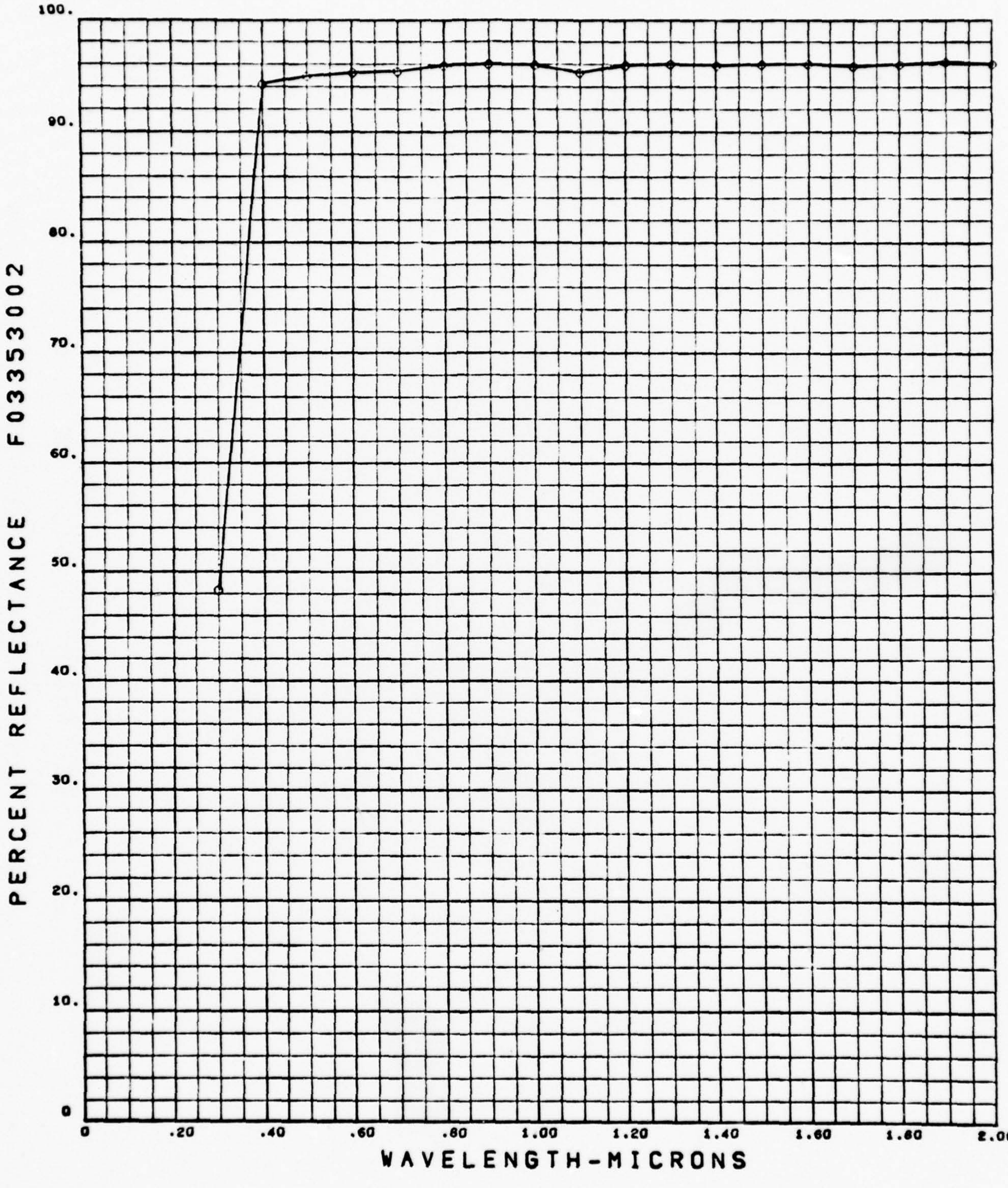

FIGURE VIII-7. DIRECTIONAL-HEMISPHERICAL REFLECTANCE (U.V., VIS., NEAR I.R.)

FUSED SILICA GROUND FRONT 3 MICRON GRIT, BACK 9 MICRON GRIT, 1.5 HOURS HF ETCH, ENHANCED SILVER

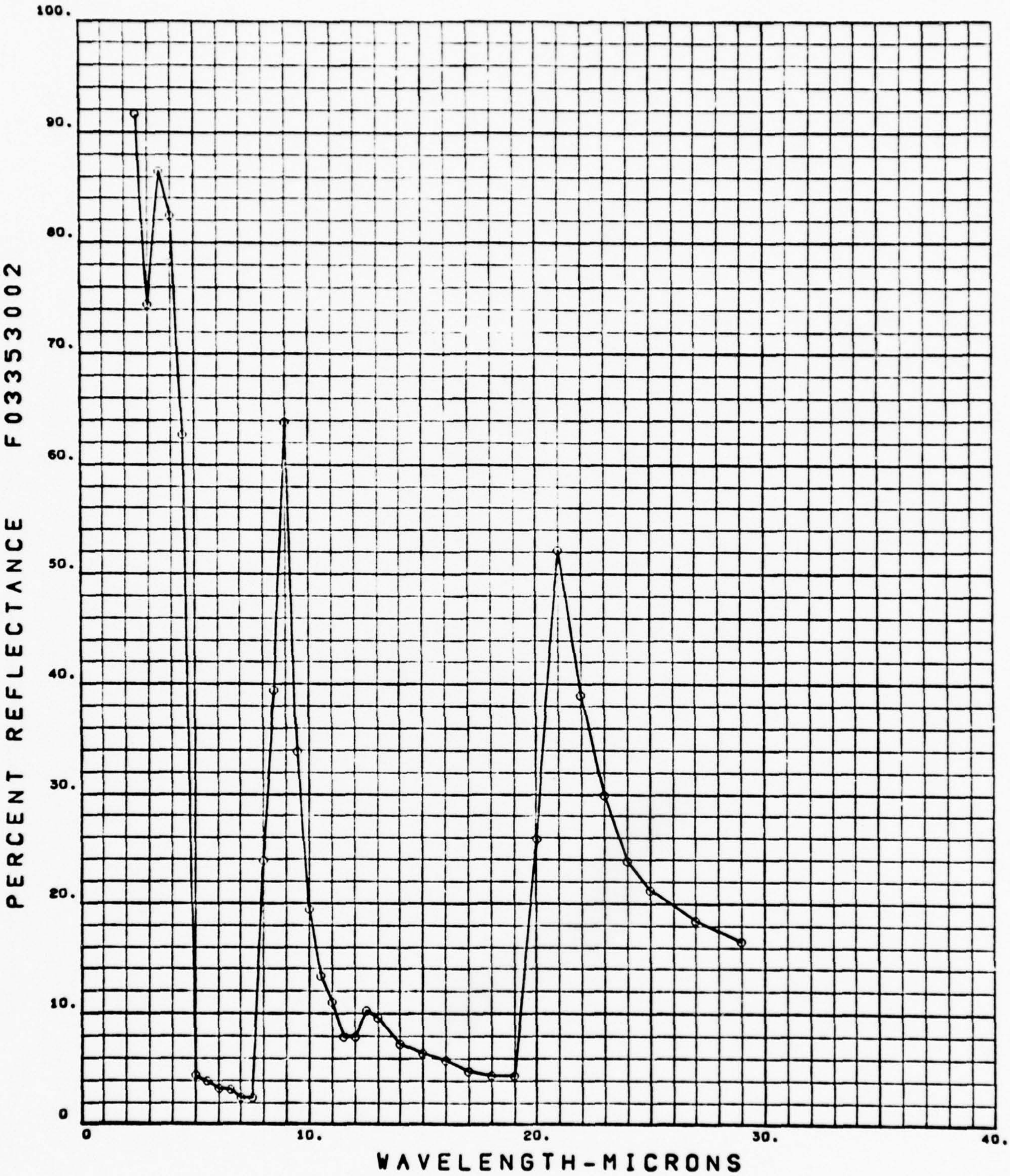

FIGURE VIII-8. DIRECTIONAL-HEMISPHERICAL REFLECTANCE (I. R.)

FUSED SILICA GROUND FRONT 3 MICRON GRIT, BACK
9 MICRON GRIT, 1.5 HOURS HF ETCH, ENHANCED SILVER

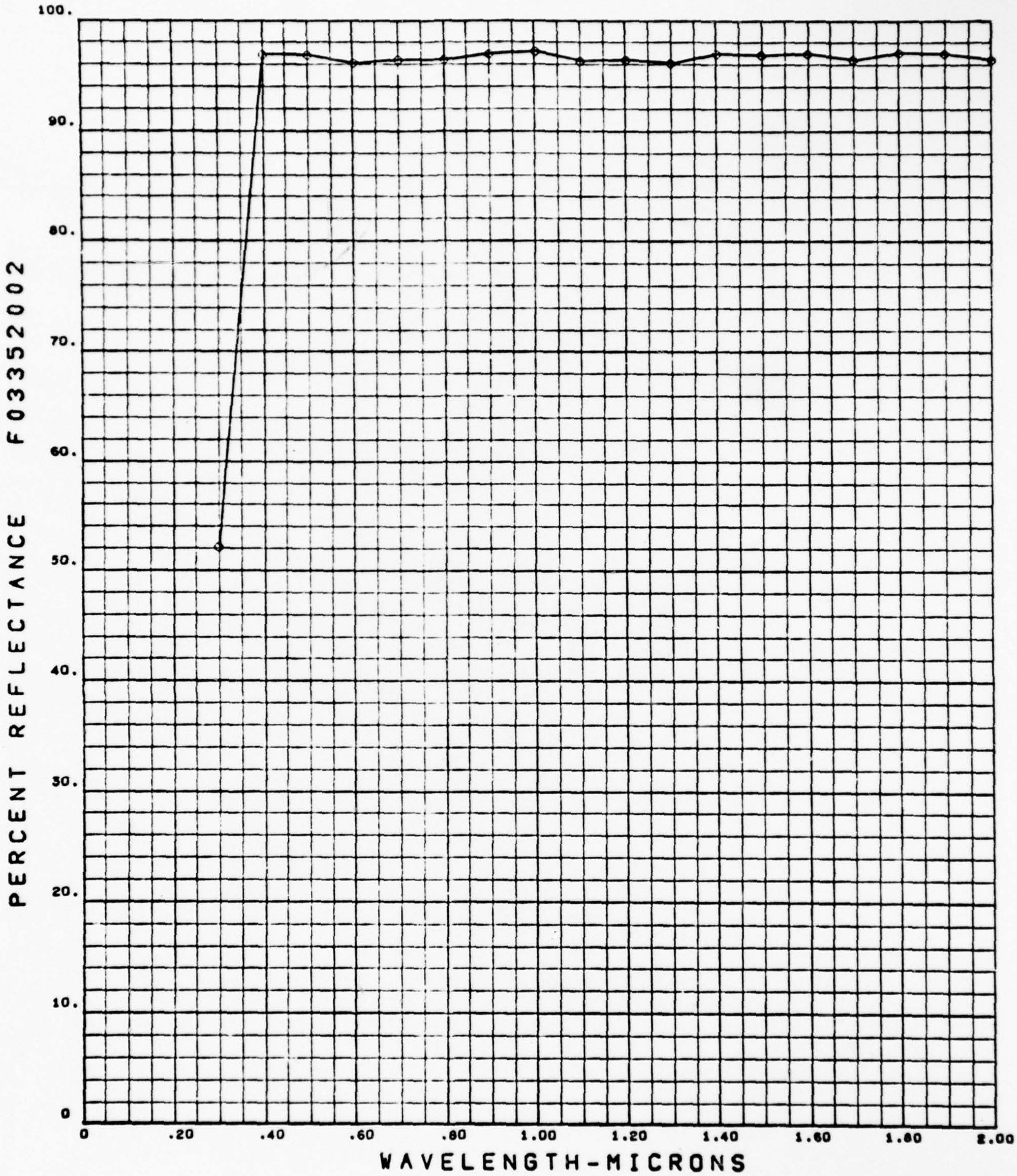

FIGURE VIII-9. DIRECTIONAL-HEMISPHERICAL REFLECTANCE (U.V., VIS., NEAR I.R.)

FUSED SILICA GROUND FRONT 3 MICRON GRIT, BACK 9 MICRON GRIT, 2.5 HOURS HF ETCH, ENHANCED SILVER

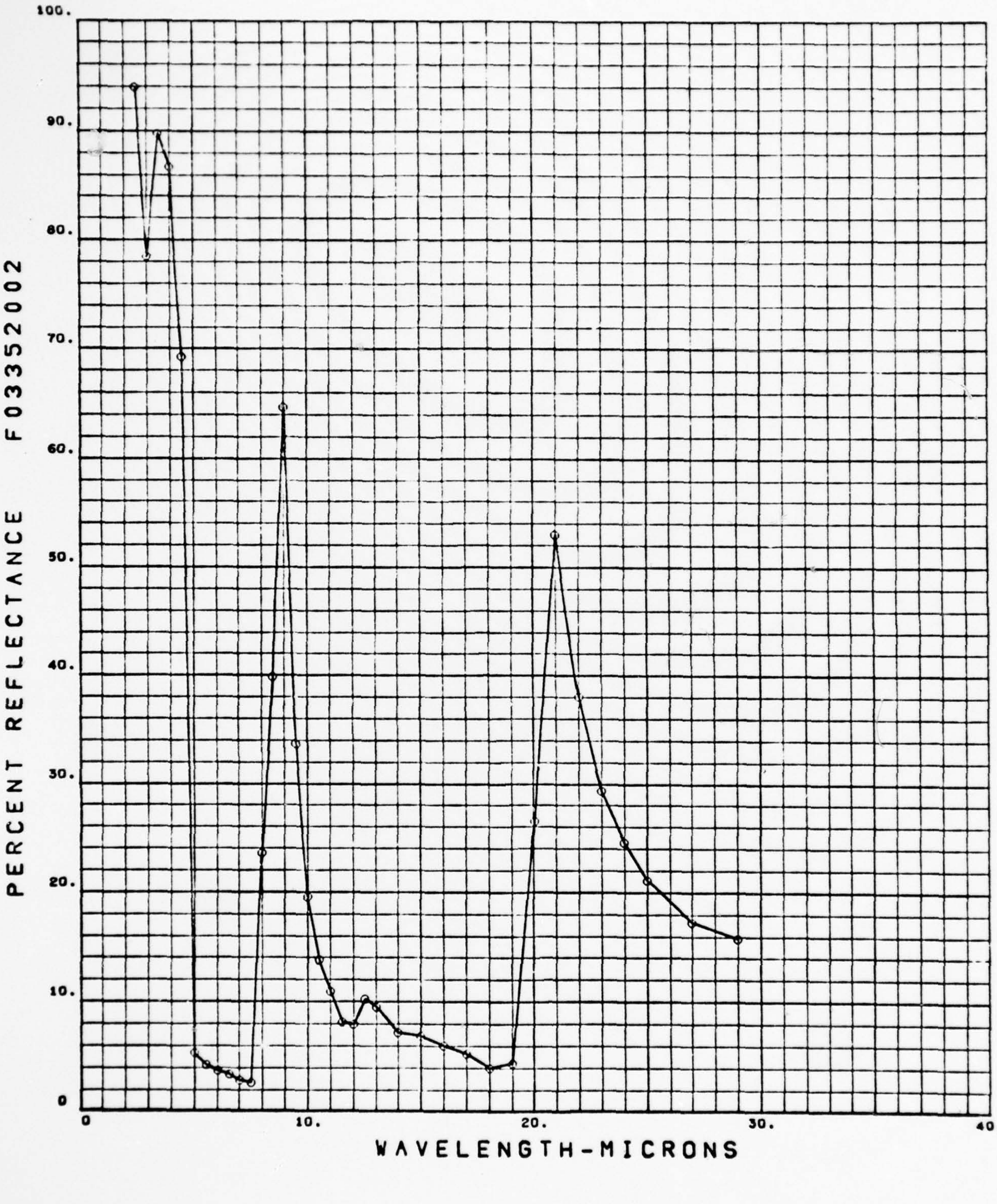

FIGURE VIII-10. DIRECTIONAL-HEMISPHERICAL REFLECTANCE (I.R.)

FUSED SILICA GROUND FRONT 3 MICRON GRIT, BACK 9 MICRON GRIT, 2.5 HOURS HF ETCH, ENHANCED SILVER

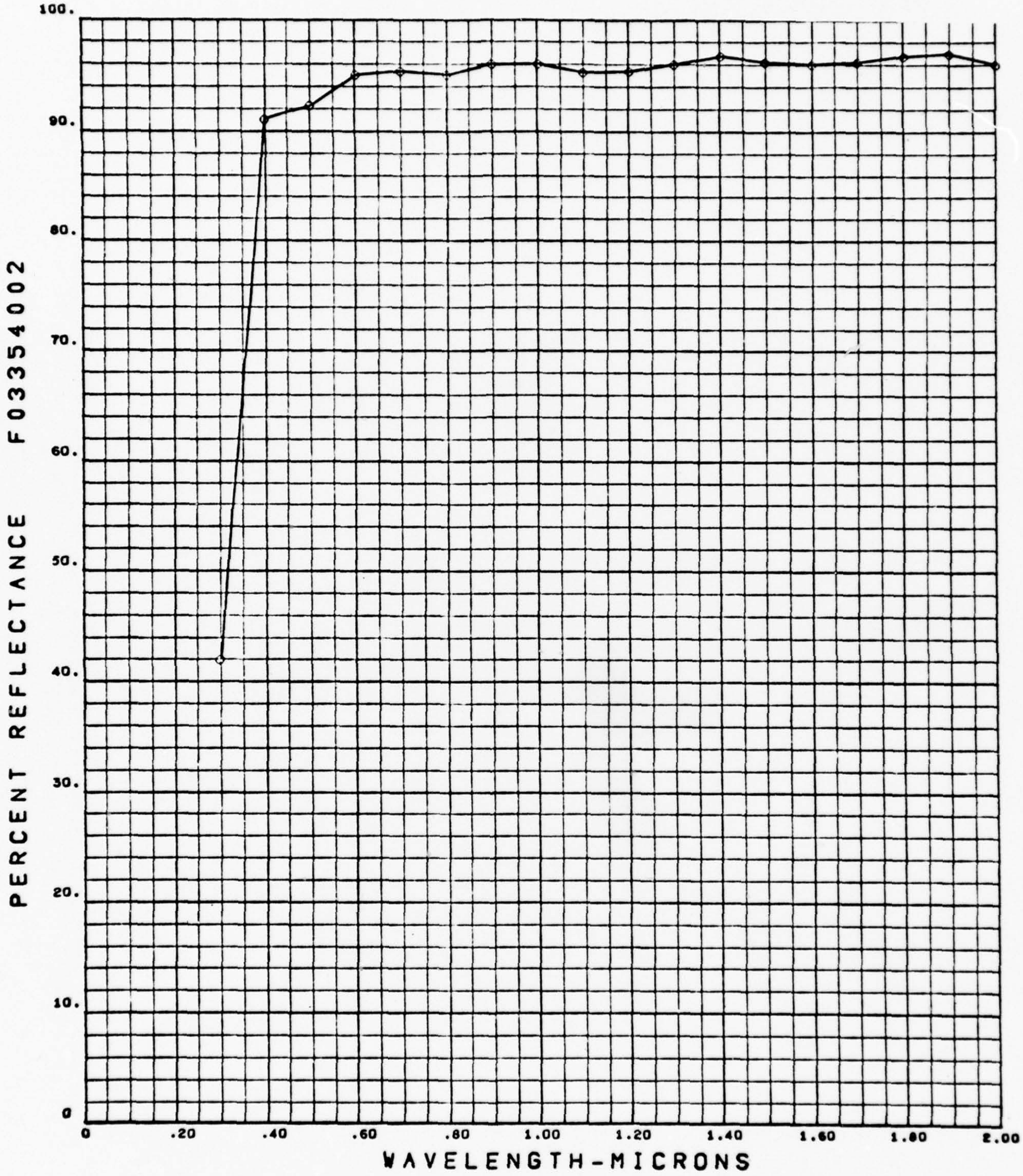

FIGURE VIII-11. DIRECTIONAL-HEMISPHERICAL REFLECTANCE (U.V., VIS., NEAR I.R.)

FUSED SILICA GROUND FRONT 30 MICRON GRIT, BACK POLISHED, 0.5 HOURS HF ETCH, ENHANCED SILVER

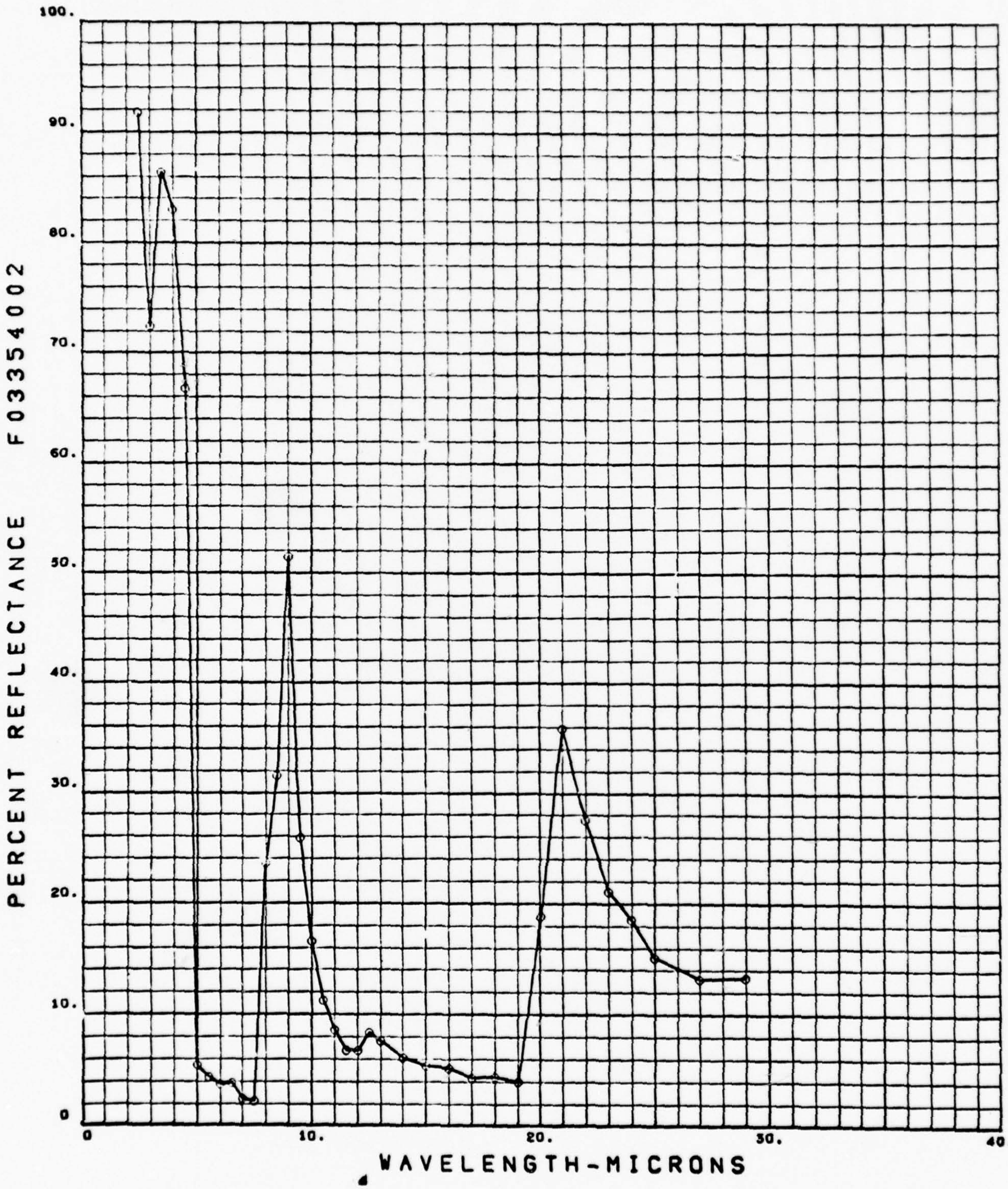

FIGURE VIII-12. DIRECTIONAL-HEMISPHERICAL REFLECTANCE (I.R.)

FUSED SILICA GROUND FRONT 30 MICRON GRIT, BACK POLISHED, 0.5 HOURS HF ETCH, ENHANCED SILVER

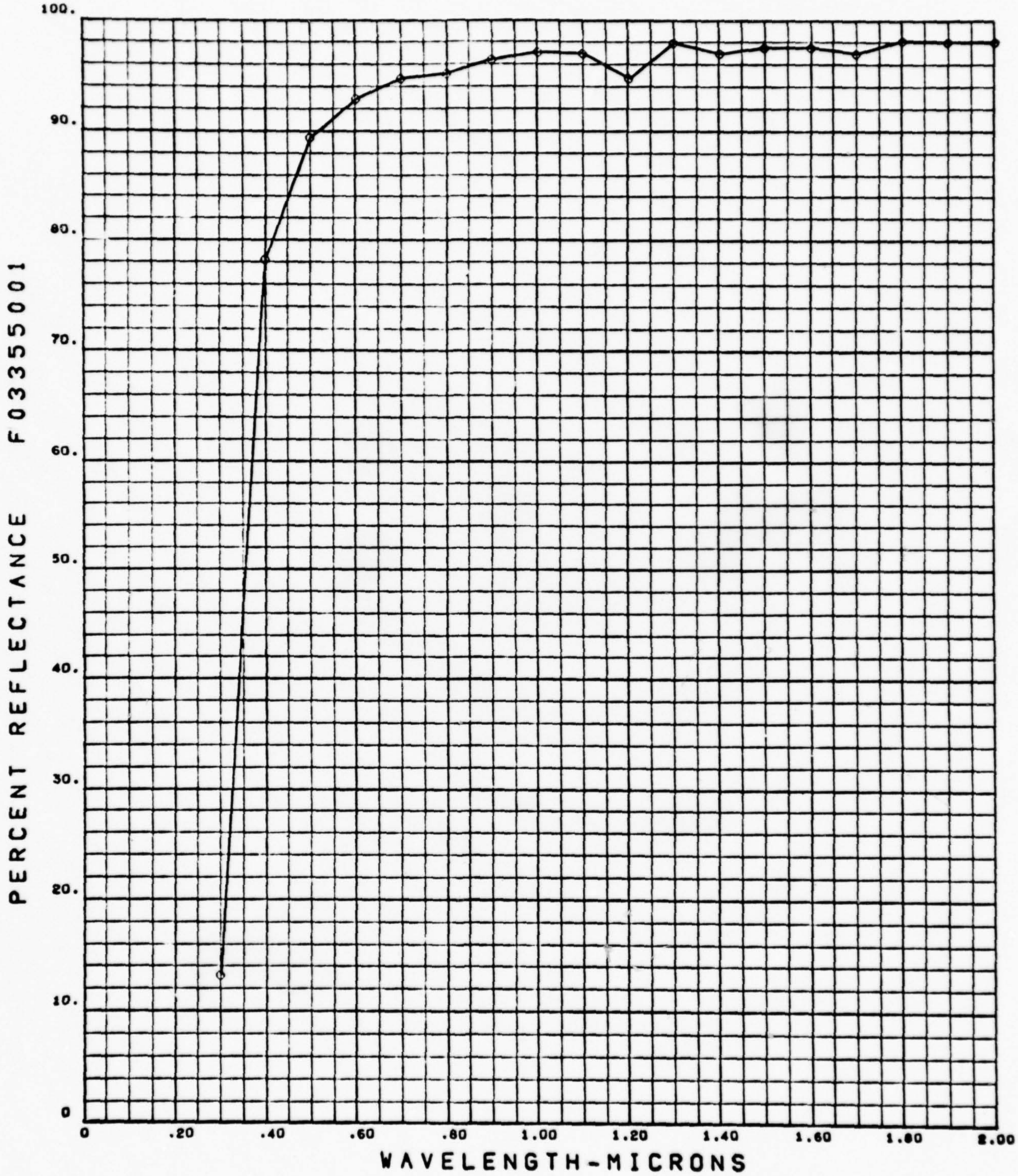

FIGURE VIII-13. DIRECTIONAL-HEMISPHERICAL REFLECTANCE (U.V., VIS., NEAR I.R.)

FEP TEFLON PRESSED BETWEEN ROUGHENED FUSED SILICA PLATES. FRONT SURFACE 3 MICRON ROUGHENED SECOND SURFACE 9 MICRON ROUGHENED. BOTH PLATES 0.83 HOURS HF ETCH SECOND SURFACE SILVERED BY SHELDAHL

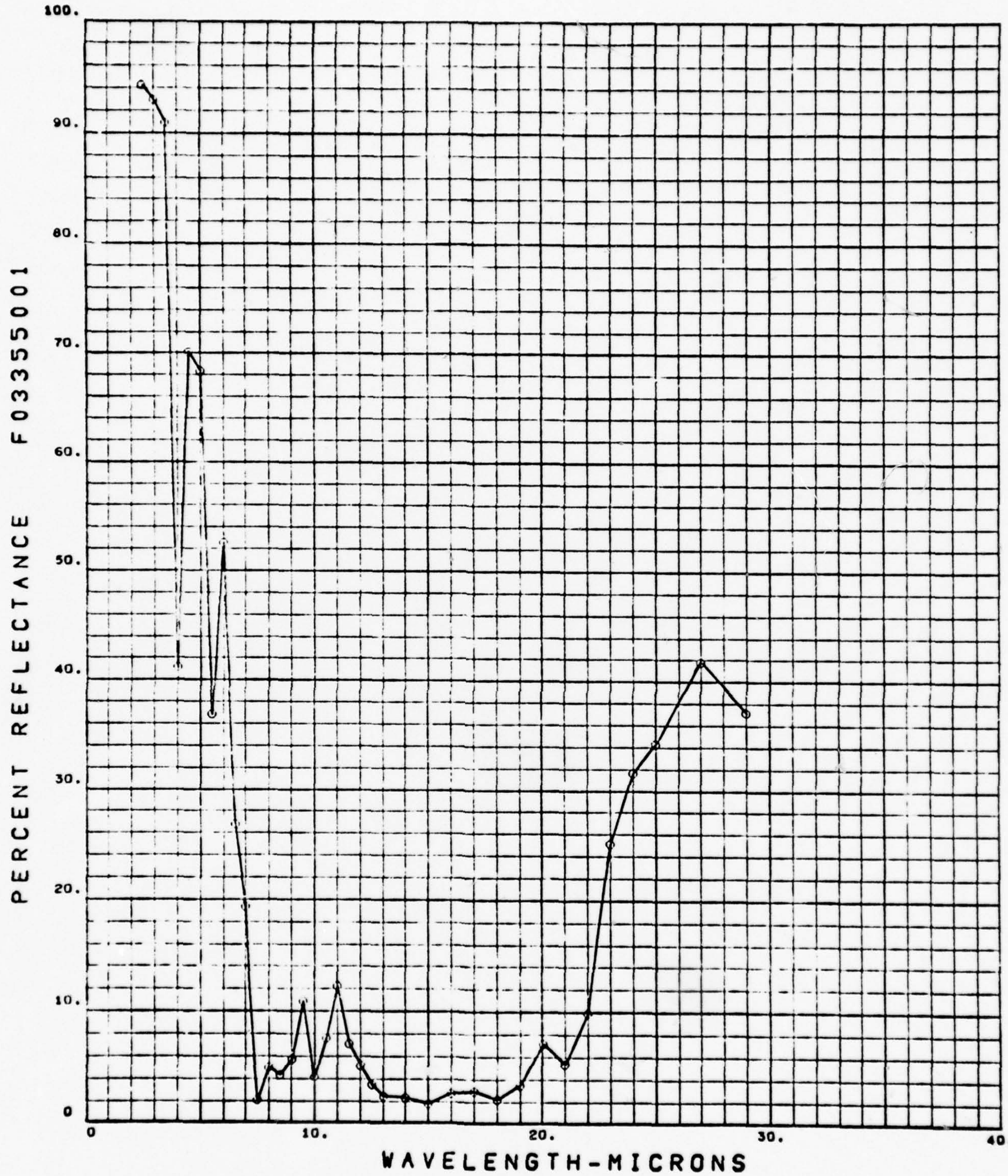

FIGURE VIII-14. DIRECTIONAL-HEMISPHERICAL REFLECTANCE (I.R.)

FEP TEFLON PRESSED BETWEEN ROUGHENED FUSED SILICA PLATES. FRONT SURFACE 3 MICRON ROUGHENED SECOND SURFACE 9 MICRON ROUGHENED. BOTH PLATES 0 83 HOURS HF ETCH SECOND SURFACE SILVERED BY SHELDAHL

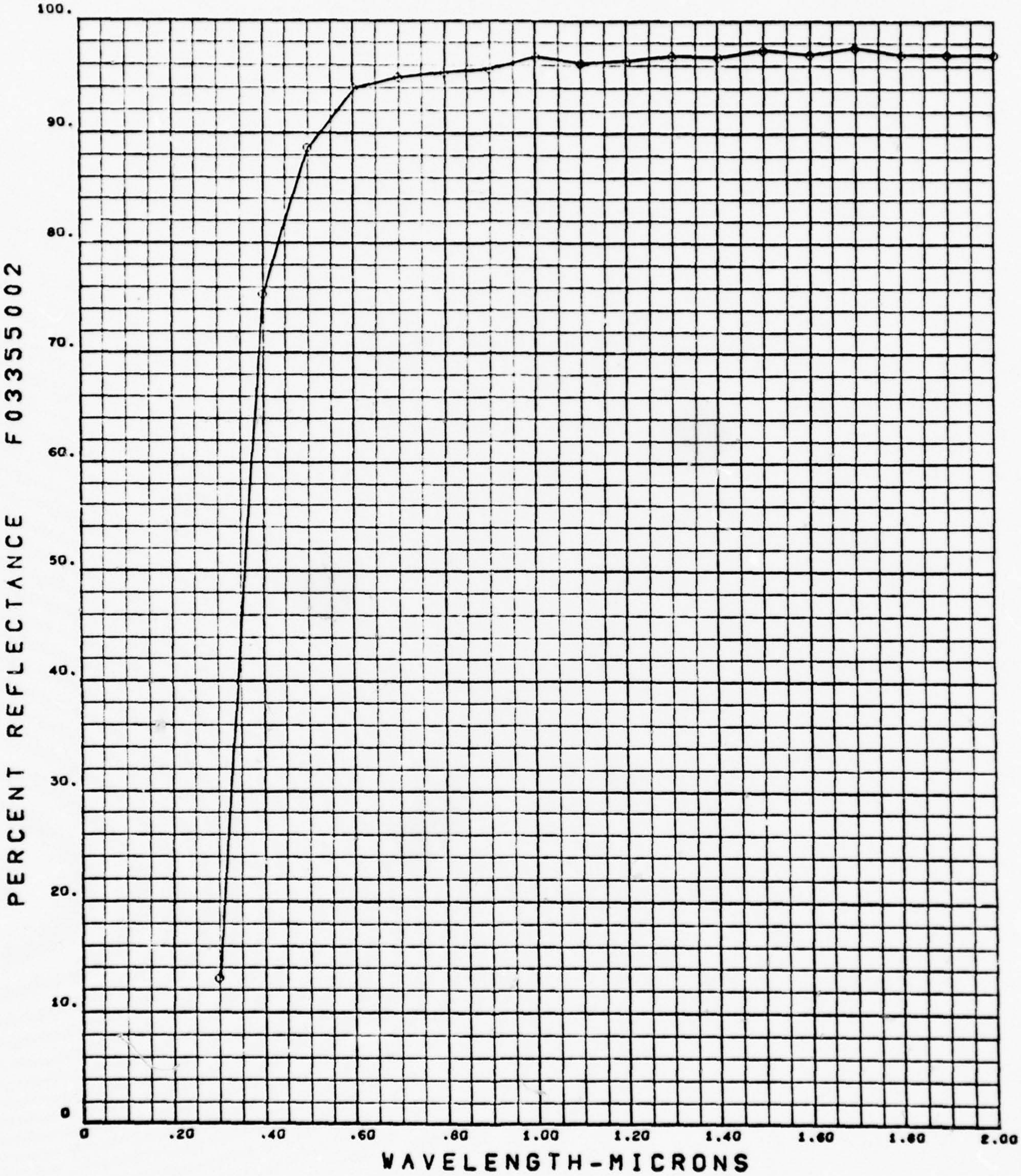

FIGURE VIII-15. DIRECTIONAL-HEMISPHERICAL REFLECTANCE (U.V., VIS., NEAR I.R.)

FEP TEFLON PRESSED BETWEEN ROUGHENED FUSED SILICA PLATES. FRONT SURFACE 3 MICRON ROUGHENED SECOND SURFACE 9 MICRON ROUGHENED. BOTH PLATES 0.83 HOURS HF ETCH SECOND SURFACE SILVERED BY SHELDAHL

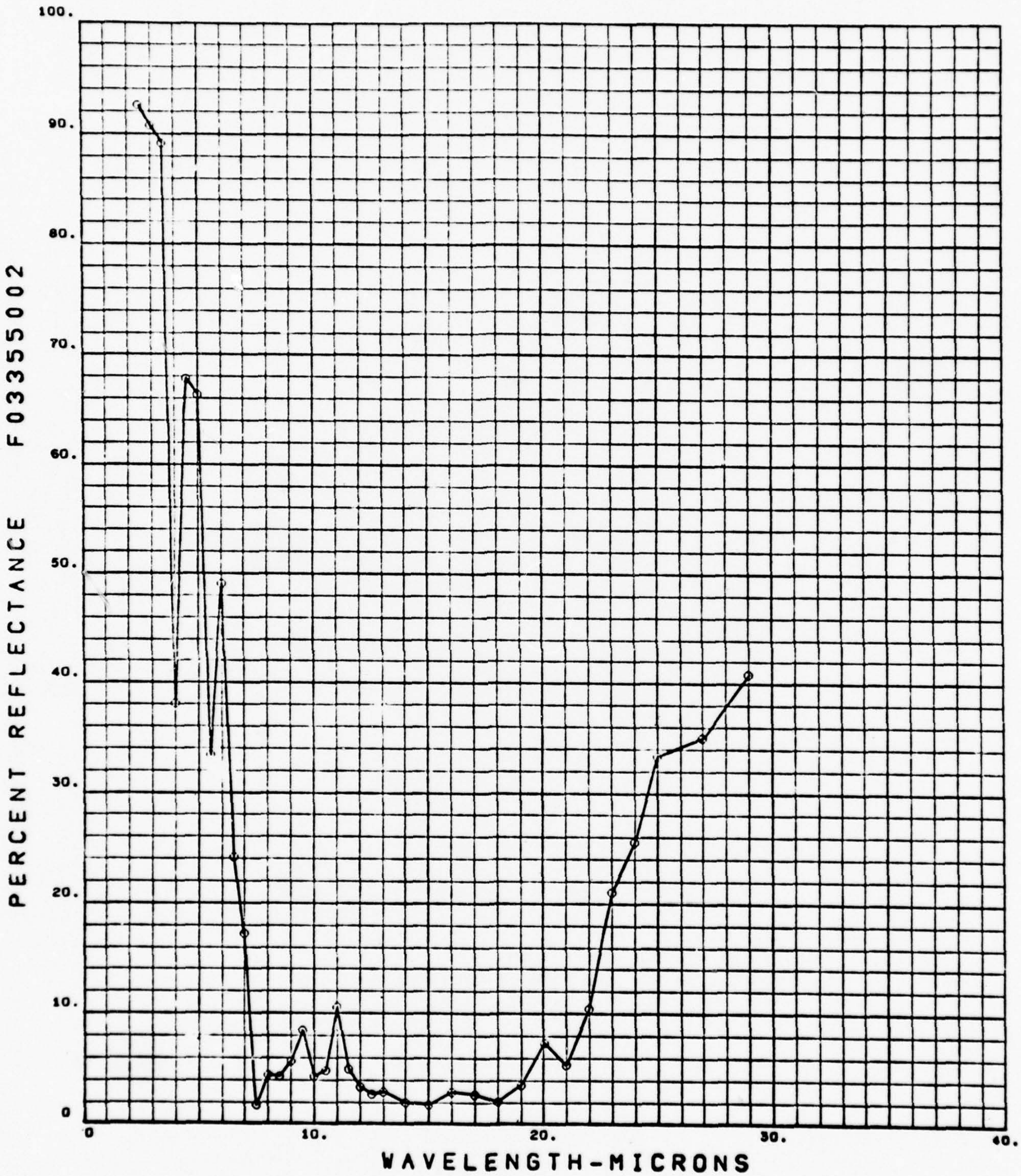

FIGURE VIII-16. DIRECTIONAL-HEMISPHERICAL REFLECTANCE (I.R.)

FEP TEFLON PRESSED BETWEEN ROUGHENED FUSED SILICA PLATES. FRONT SURFACE 3 MICRON ROUGHENED SECOND SURFACE 9 MICRON ROUGHENED. BOTH PLATES 0.83 HOURS HF ETCH SECOND SURFACE SILVERED BY SHELDAHL

ANNEX IX

BIDIRECTIONAL REFLECTANCE

This annex provides graphs of the bidirectional reflectance in both two and three dimensional form at 0.5 μm. Angles are defined in Figure III-1 of Annex III.

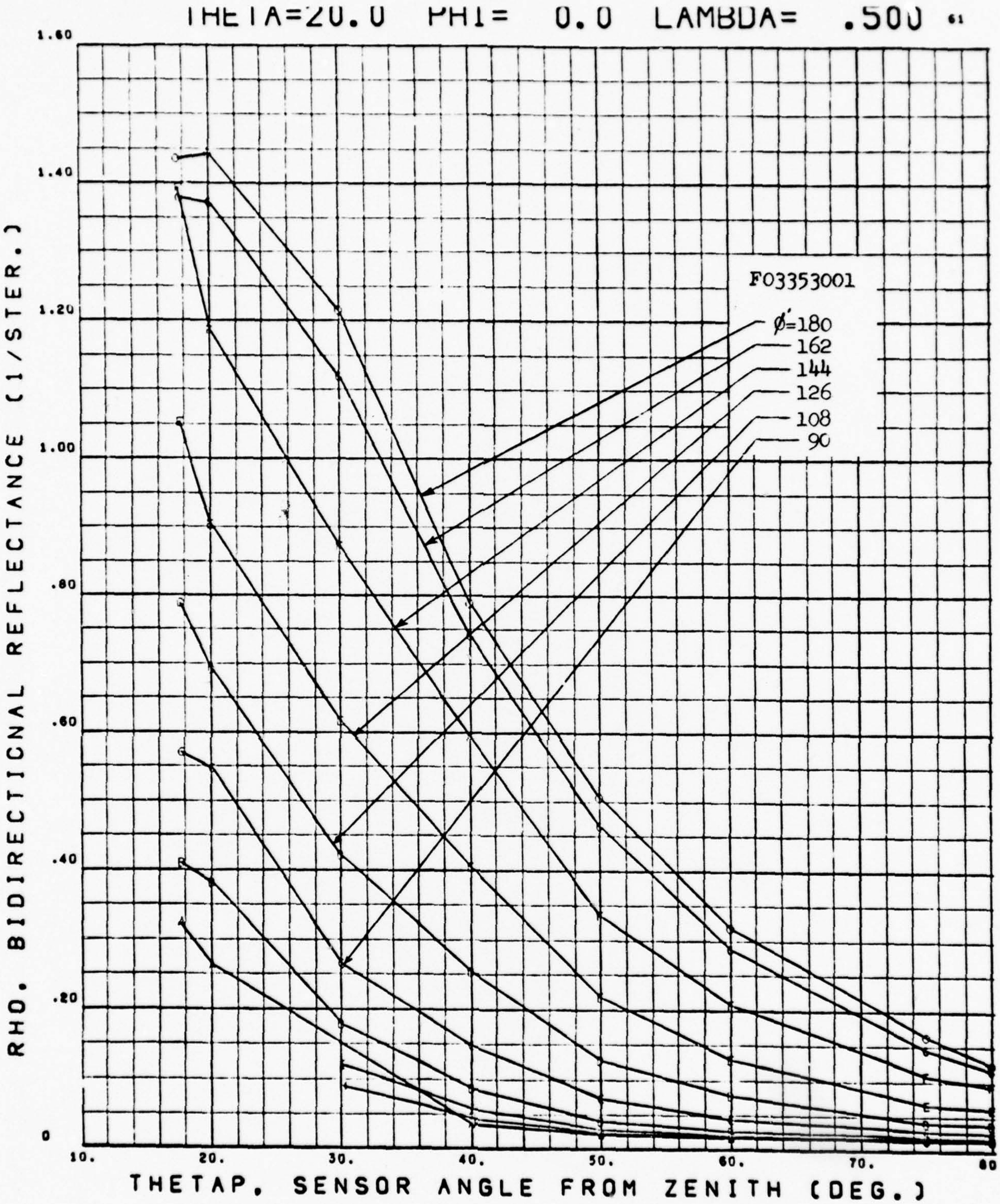

FIGURE IX-1 BIDIRECTIONAL REFLECTANCE

FUSED SILICA GROUND FRONT 3 MICRON GRIT, BACK 9 MICRON GRIT, 1.5 HOURS HF ETCH, NON-ENHANCED SILVER

.5 MICRONS THETA-20 DEGREES

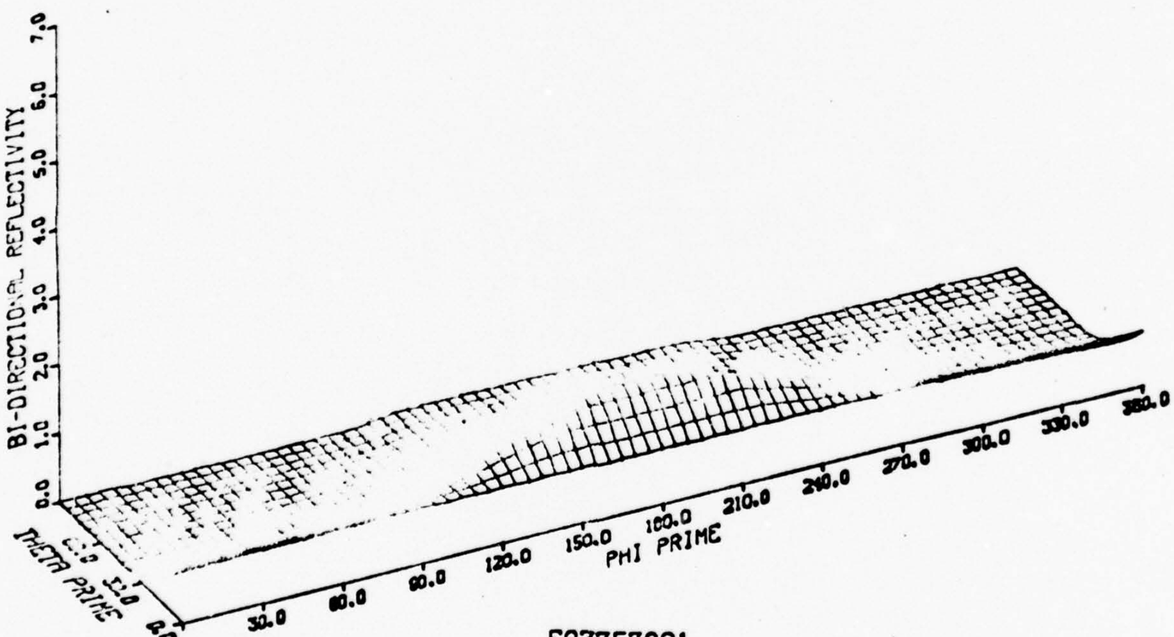

FIGURE IX-2 BIDIRECTIONAL REFLECTANCE

FUSED SILICA GROUND FRONT 3 MICRON GRIT, BACK 9 MICRON GRIT, 1.5 HOURS HF ETCH, NON-ENHANCED SILVER

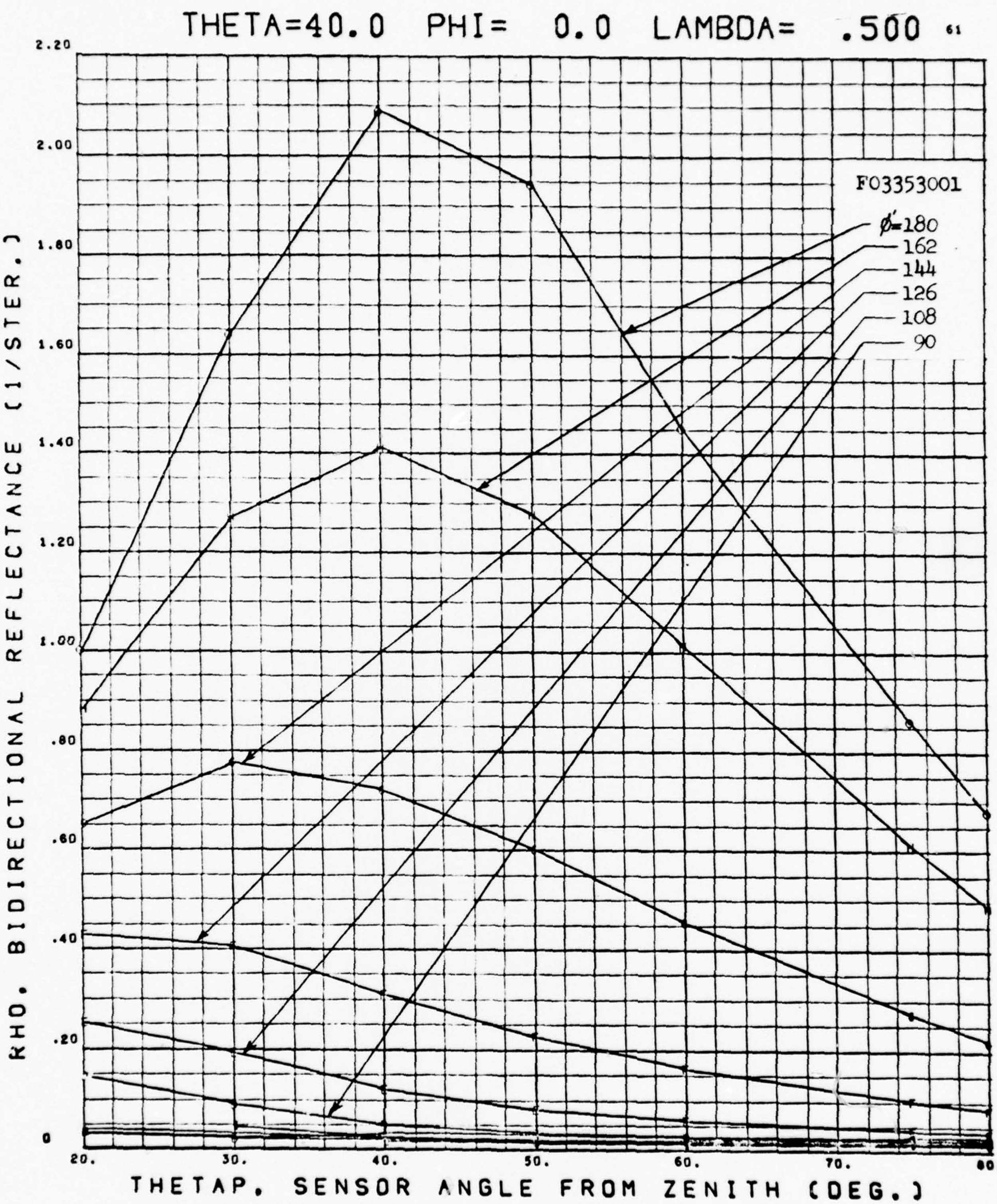

FIGURE IX-3 BIDIRECTIONAL REFLECTANCE

FUSED SILICA GROUND FRONT 3 MICRON GRIT, BACK 9 MICRON GRIT, 1.5 HOURS HF ETCH, NON-ENHANCED SILVER

.5 MICRONS THETA=40 DEGREES

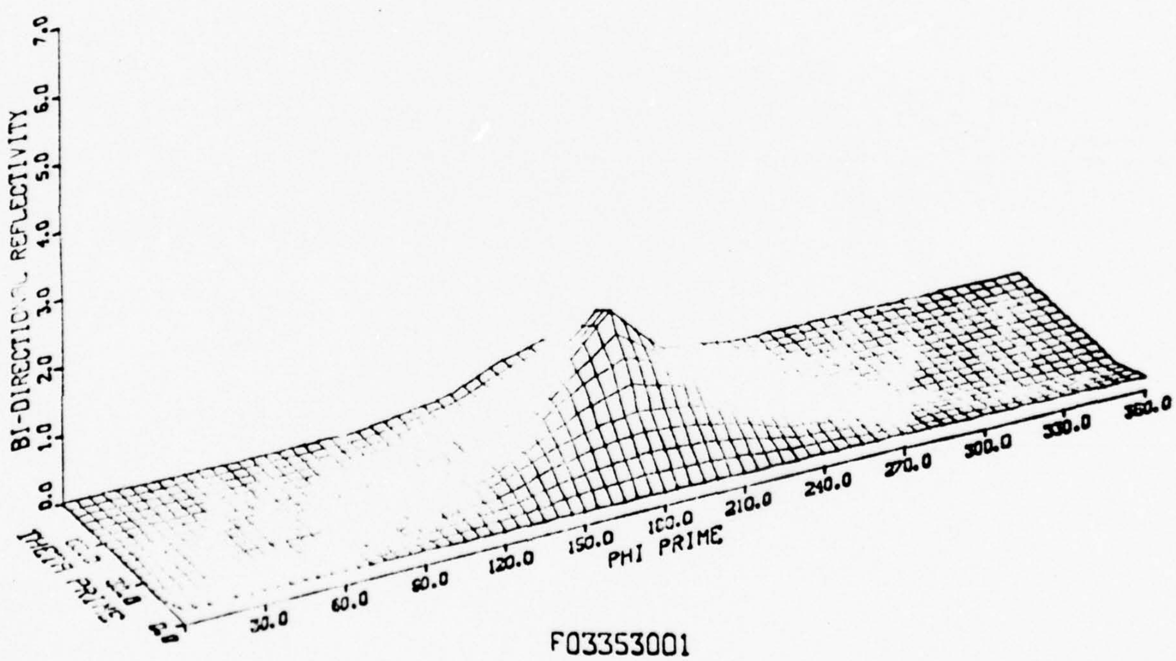

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FIGURE IX-4 BIDIRECTIONAL REFLECTANCE

FUSED SILICA GROUND FRONT 3 MICRON GRIT, BACK 9 MICRON GRIT, 1.5 HOURS HF ETCH, NON-ENHANCED SILVER

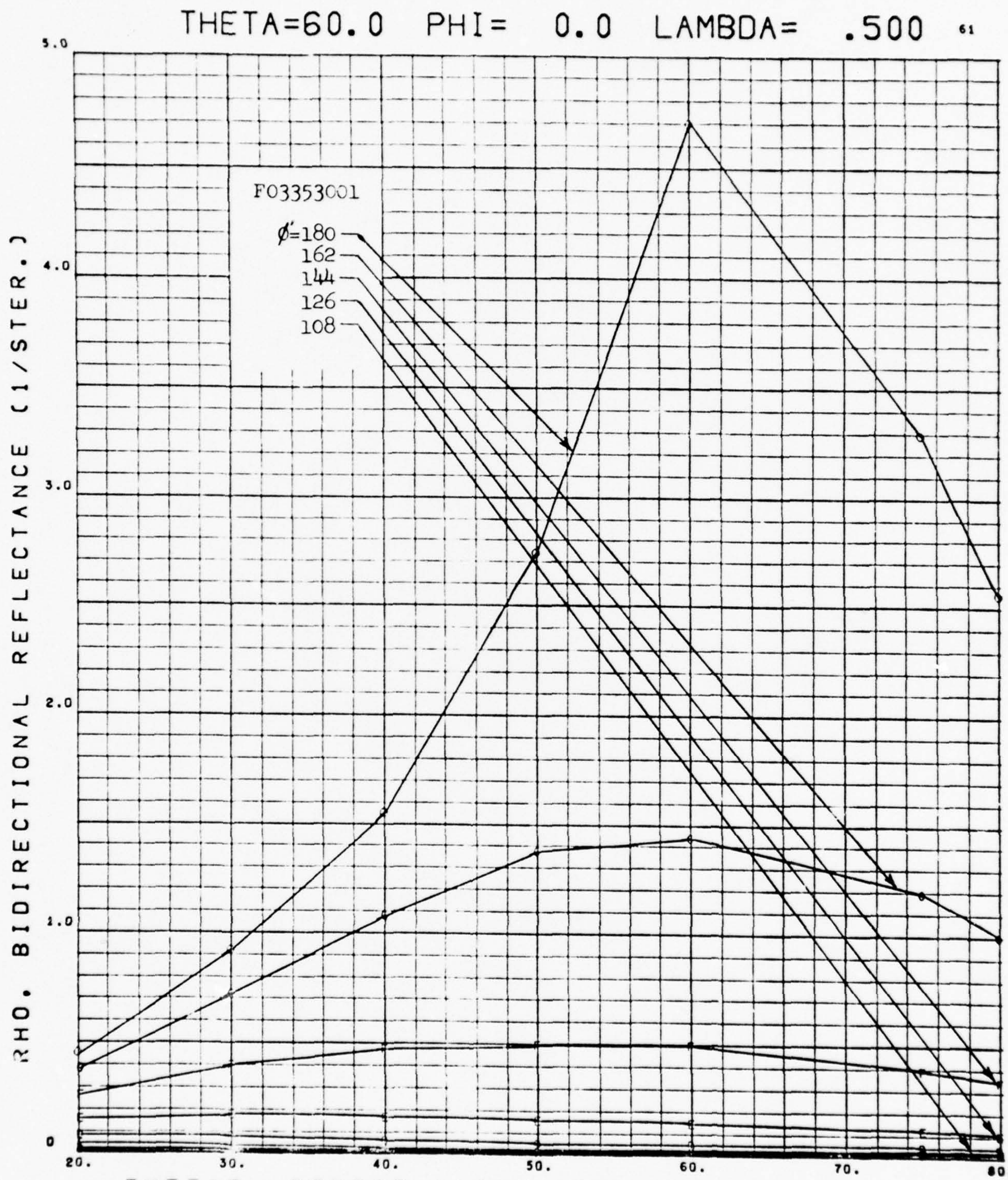
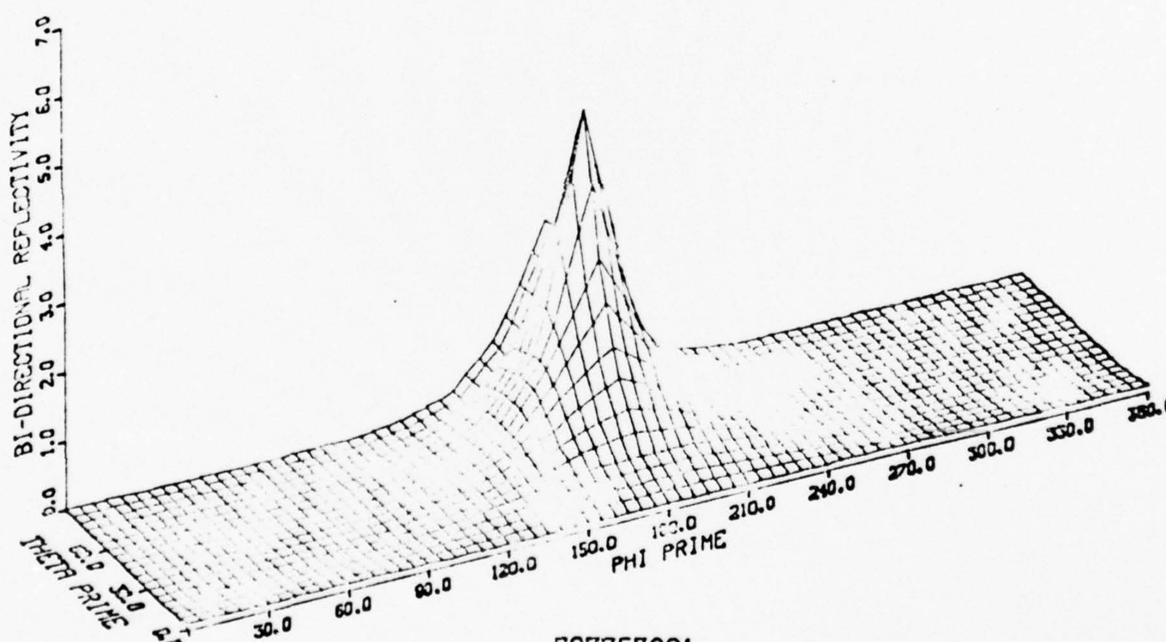


FIGURE IX-6 BIDIRECTIONAL REFLECTANCE

FUSED SILICA GROUND FRONT 3 MICRON GRIT, BACK 9 MICRON GRIT, 1.5 HOURS HF ETCH, NON-ENHANCED SILVER

.5 MICRONS   THETA=60 DEGREES



F03353001

FIGURE IX-6   BIDIRECTIONAL REFLECTANCE

FUSED SILICA GROUND FRONT 3 MICRON GRIT, BACK 9 MICRON GRIT, 1.5 HOURS HF ETCH, NON-ENHANCED SILVER

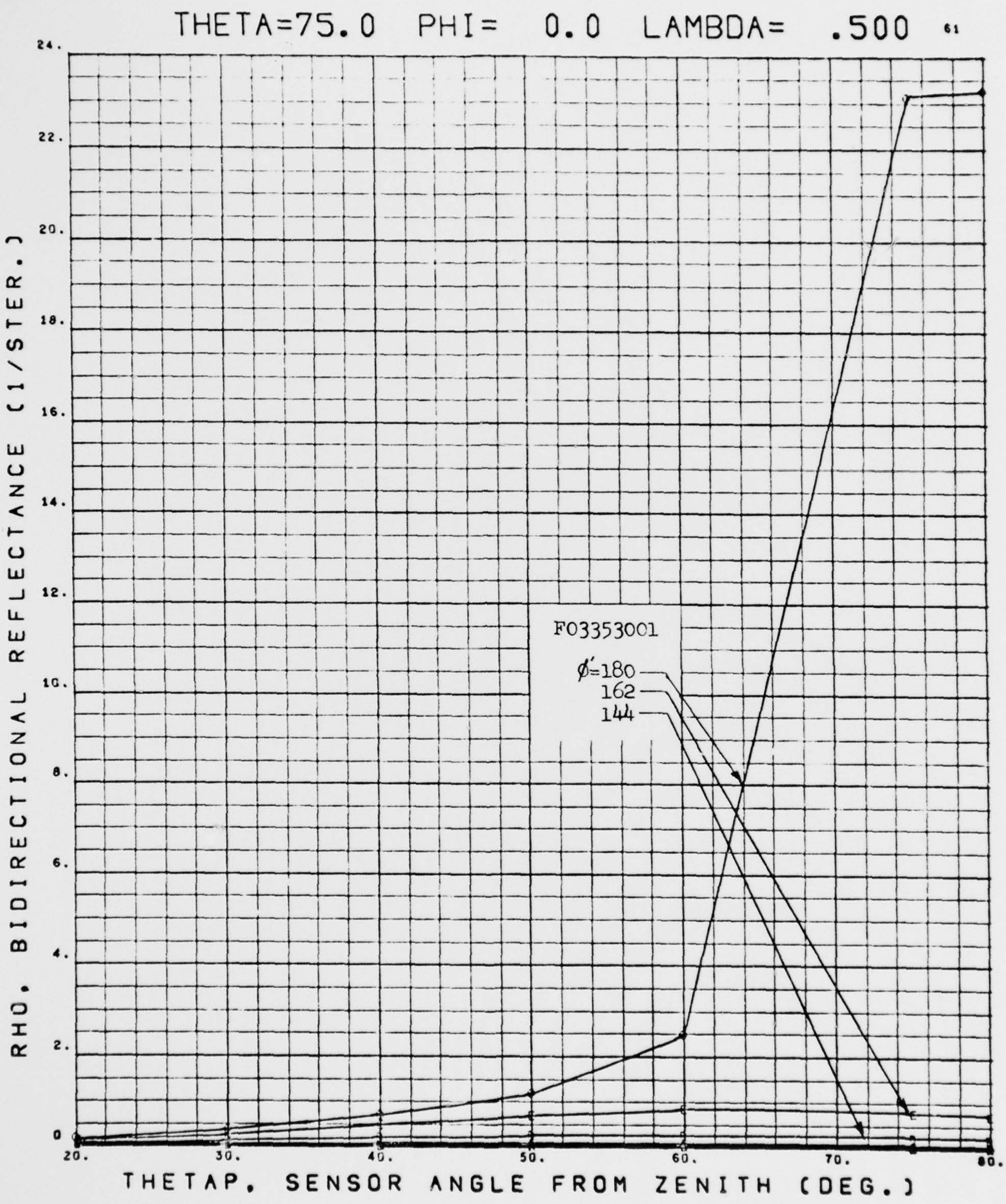


FIGURE IX-7 BIDIRECTIONAL REFLECTANCE

FUSED SILICA GROUND FRONT 3 MICRON GRIT, BACK 9 MICRON GRIT, 1.5 HOURS HF ETCH, NON-ENHANCED SILVER

.5 MICRONS THETA-75 DEGREES

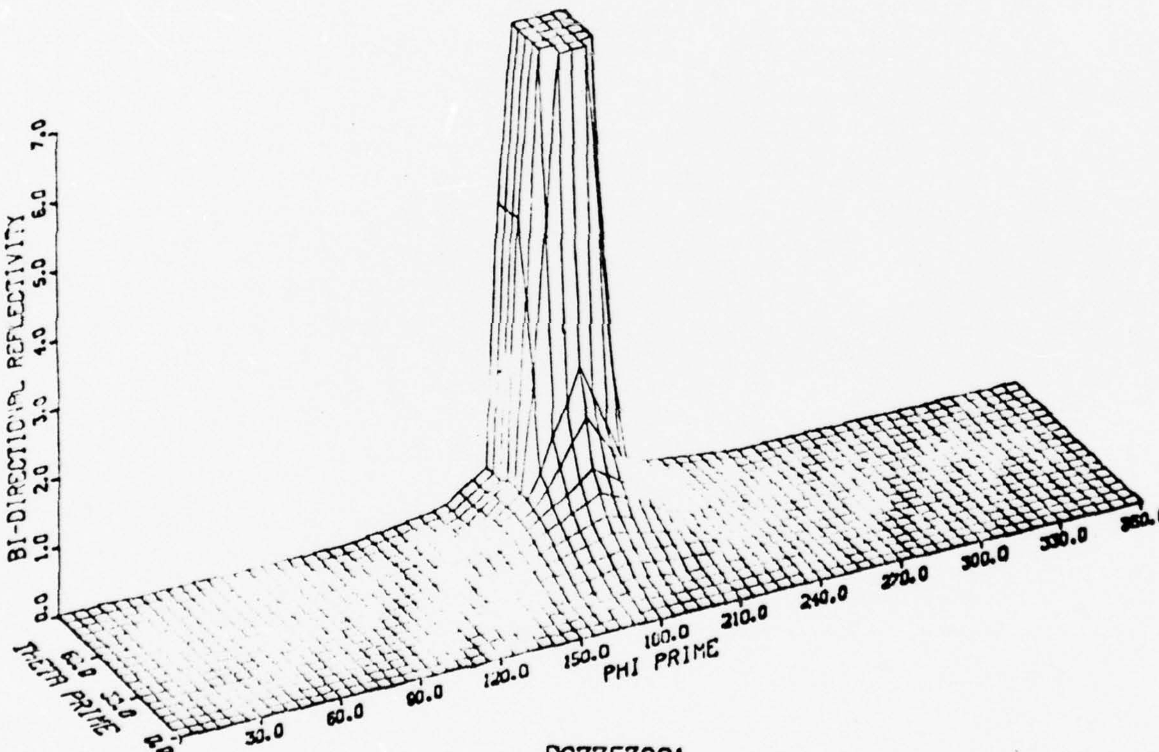


FIGURE IX-8 BIDIRECTIONAL REFLECTANCE

FUSED SILICA GROUND FRONT 3 MICRON GRIT, BACK 9 MICRON GRIT, 1.5 HOURS HF ETCH, NON-ENHANCED SILVER

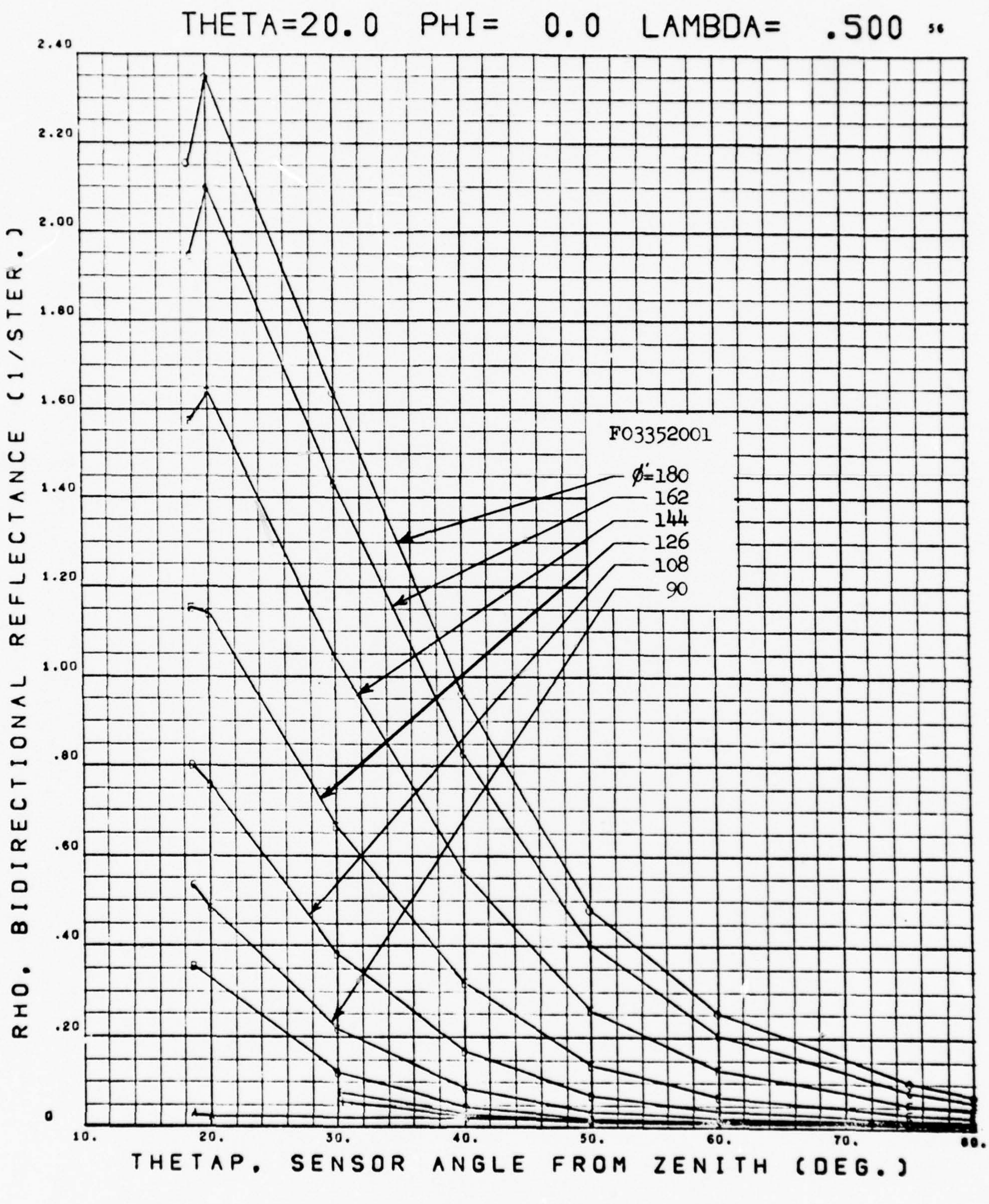
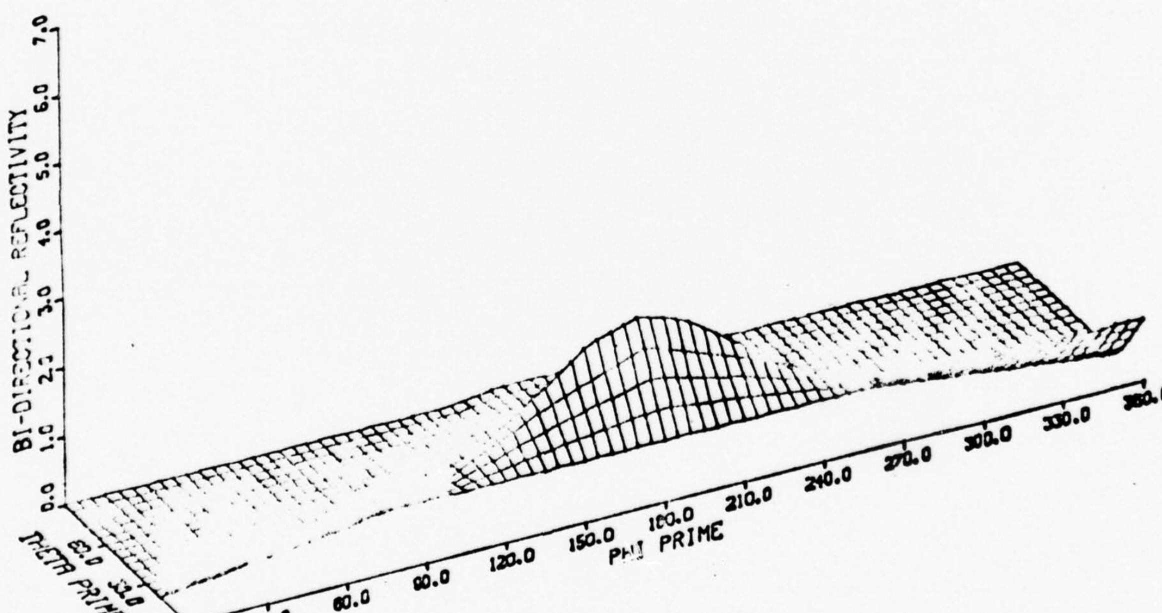


FIGURE IX-9 BIDIRECTIONAL REFLECTANCE

FUSED SILICA GROUND FRONT 3 MICRON GRIT, BACK 9 MICRON GRIT, 2.5 HOURS HF ETCH, NON-ENHANCED SILVER

.5 MICRONS THETA-20 DEGREES



F03352001

FIGURE IX-10 BIDIRECTIONAL REFLECTANCE

FUSED SILICA GROUND FRONT 3 MICRON GRIT, BACK 9 MICRON GRIT, 2.5 HOURS HF ETCH, NON-ENHANCED SILVER

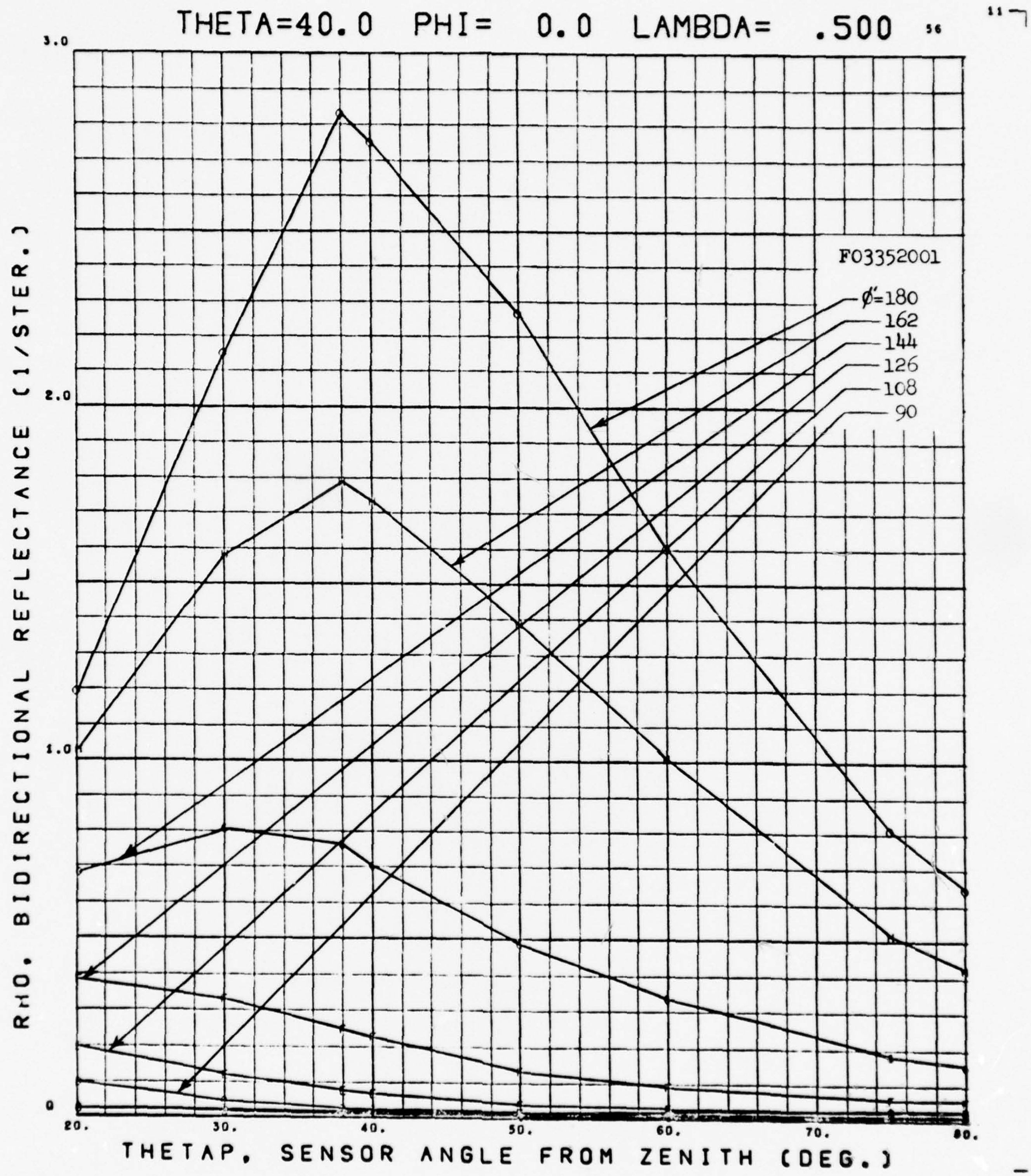


FIGURE IX-11 BIDIRECTIONAL REFLECTANCE

FUSED SILICA GROUND FRONT 3 MICRON GRIT, BACK 9 MICRON GRIT, 2.5 HOURS HF ETCH, NON-ENHANCED SILVER

.5 MICRONS THETA-40 DEGREES

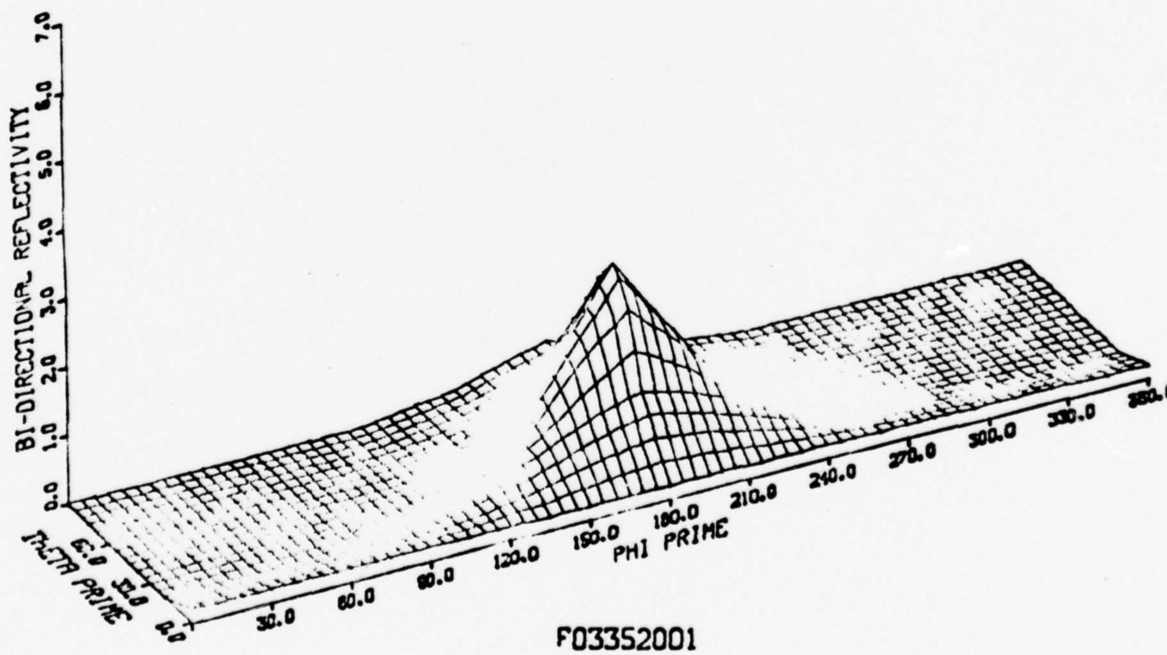


FIGURE IX-12 BIDIRECTIONAL REFLECTANCE

FUSED SILICA GROUND FRONT 3 MICRON GRIT, BACK 9 MICRON GRIT, 2.5 HOURS HF ETCH, NON-ENHANCED SILVER

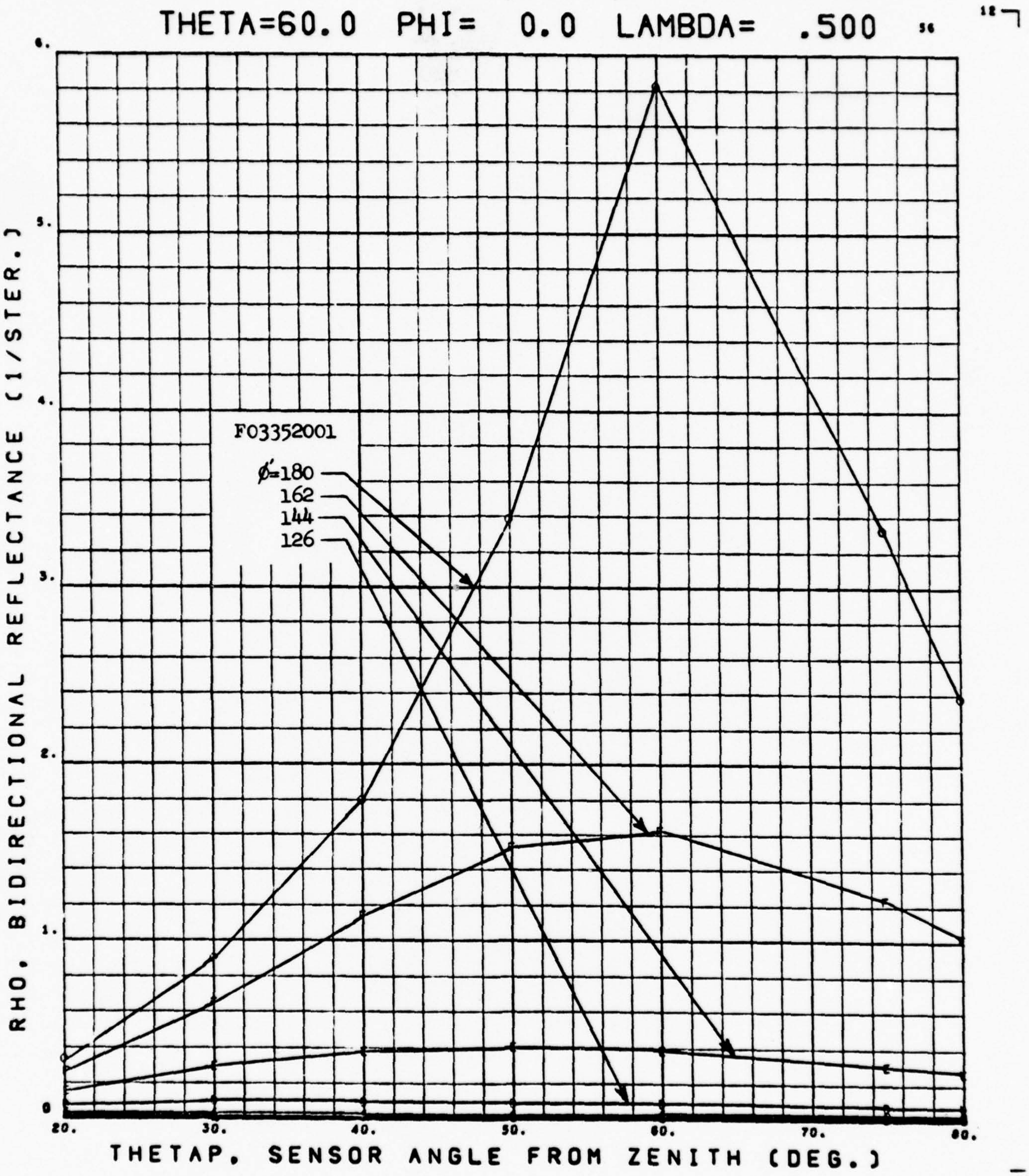


FIGURE IX-13 BIDIRECTIONAL REFLECTANCE

FUSED SILICA GROUND FRONT 3 MICRON GRIT, BACK 9 MICRON GRIT, 2.5 HOURS HF ETCH, NON-ENHANCED SILVER

.5 MICRONS THETA-60 DEGREES

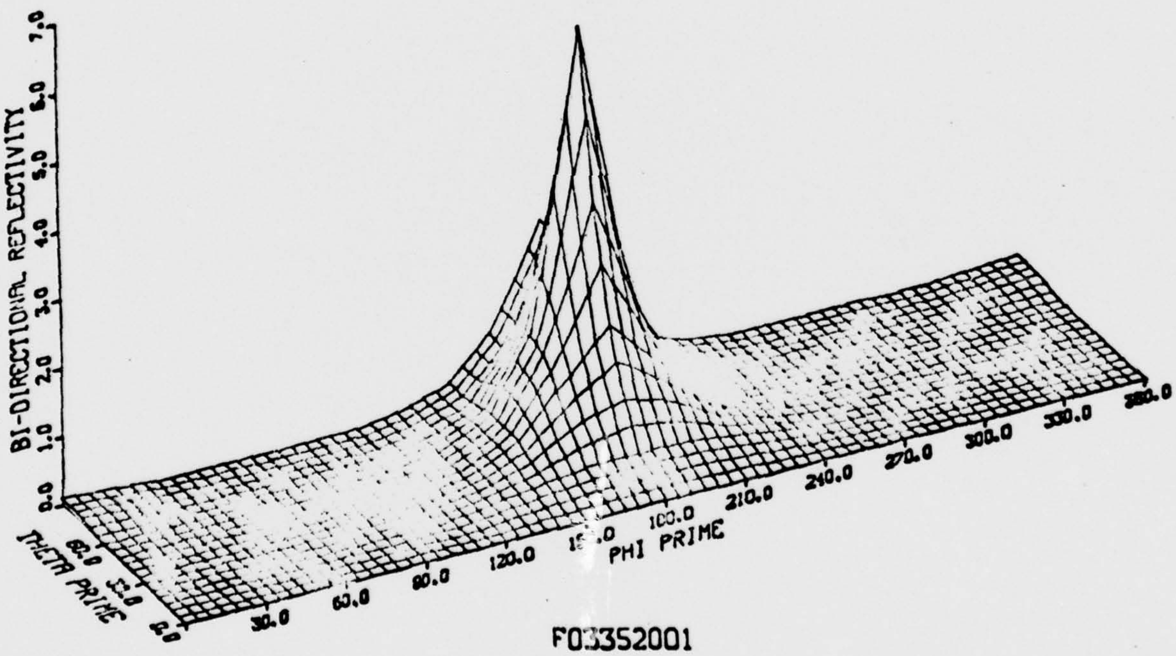


FIGURE IX-14 BIDIRECTIONAL REFLECTANCE

FUSED SILICA GROUND FRONT 3 MICRON GRIT, BACK 9 MICRON GRIT, 2.5 HOURS HF ETCH, NON-ENHANCED SILVER

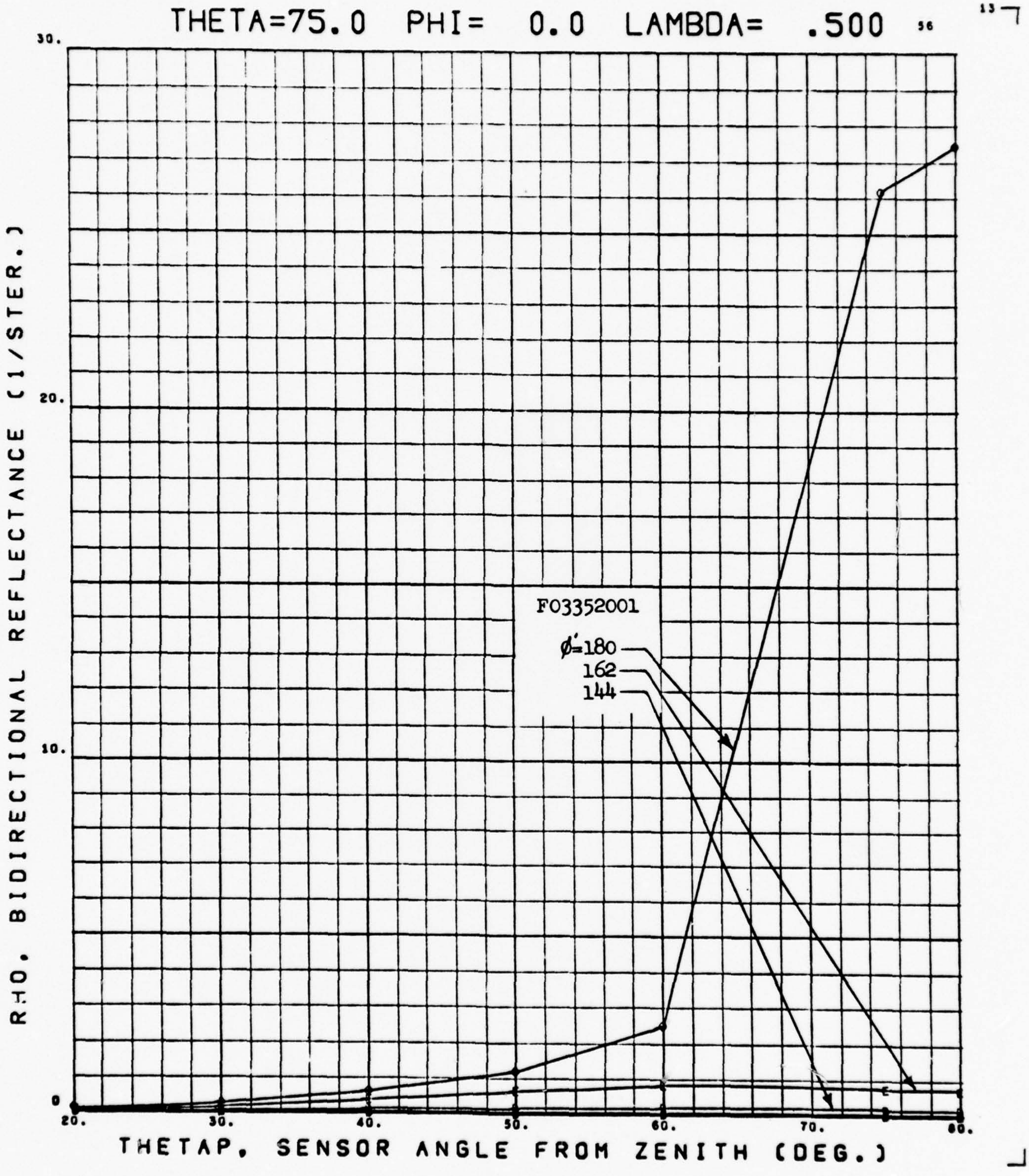


FIGURE IX-15 BIDIRECTIONAL REFLECTANCE

FUSED SILICA GROUND FRONT 3 MICRON GRIT, BACK 9 MICRON GRIT, 2.5 HOURS HF ETCH, NON-ENHANCED SILVER

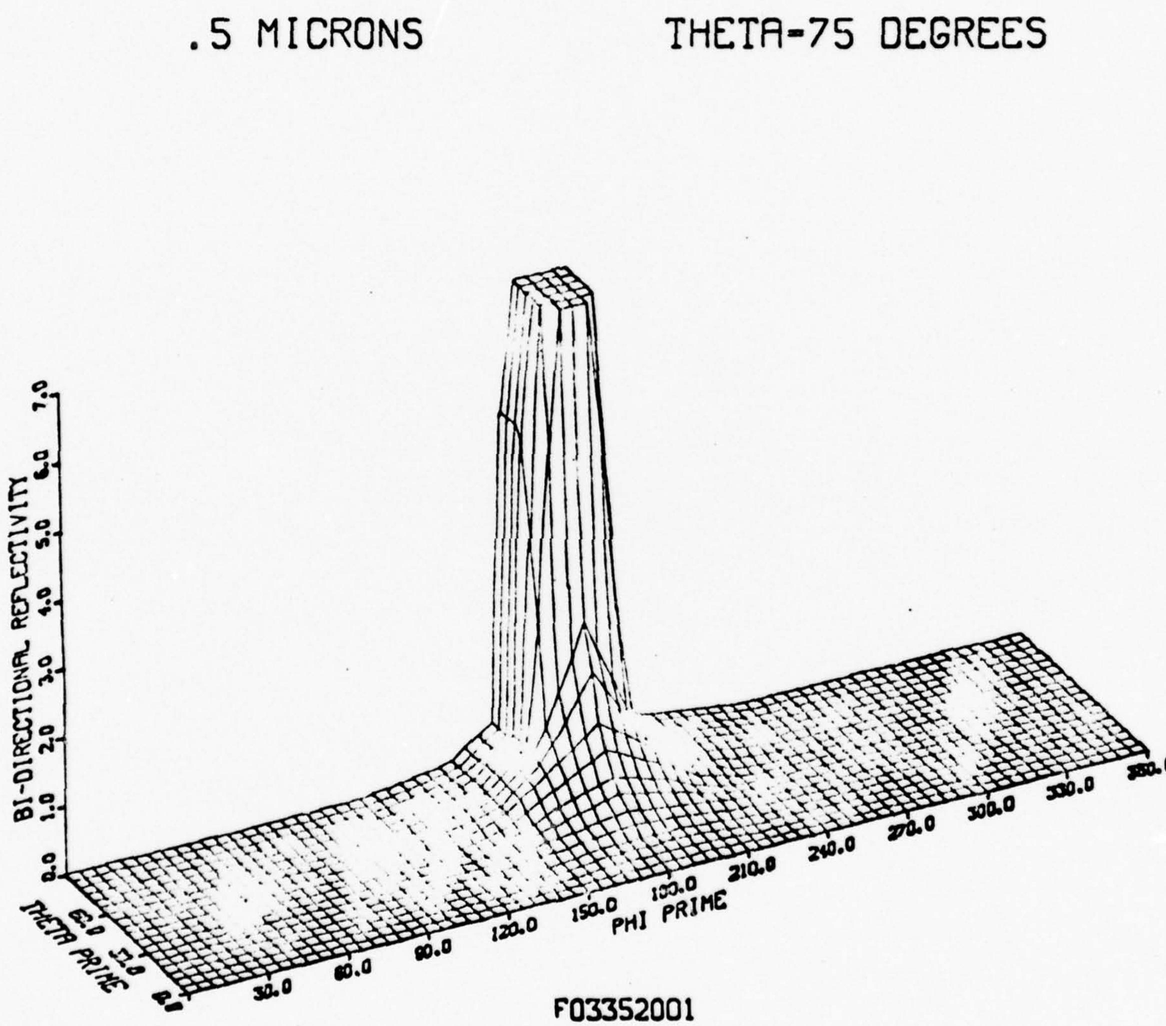


FIGURE IX-16 BIDIRECTIONAL REFLECTANCE

FUSED SILICA GROUND FRONT 3 MICRON GRIT, BACK 9 MICRON GRIT, 2.5 HOURS HF ETCH, NON-ENHANCED SILVER

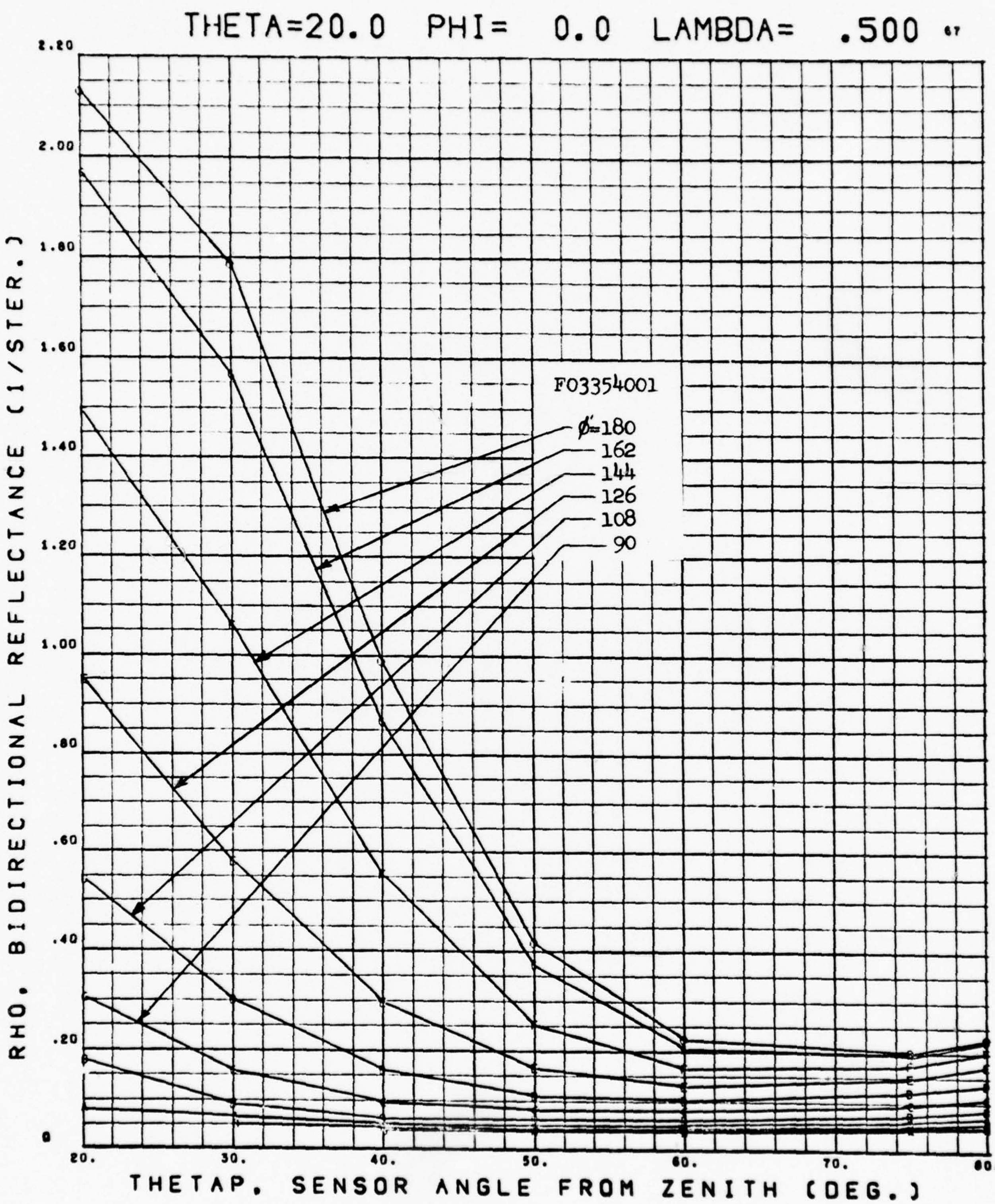


FIGURE IX-17 BIDIRECTIONAL REFLECTANCE

FUSED SILICA GROUND FRONT 30 MICRON GRIT, BACK POLISHED, 0.5 HOURS HF ETCH, NON-ENHANCED SILVER

.5 MICRONS THETA-20 DEGREES

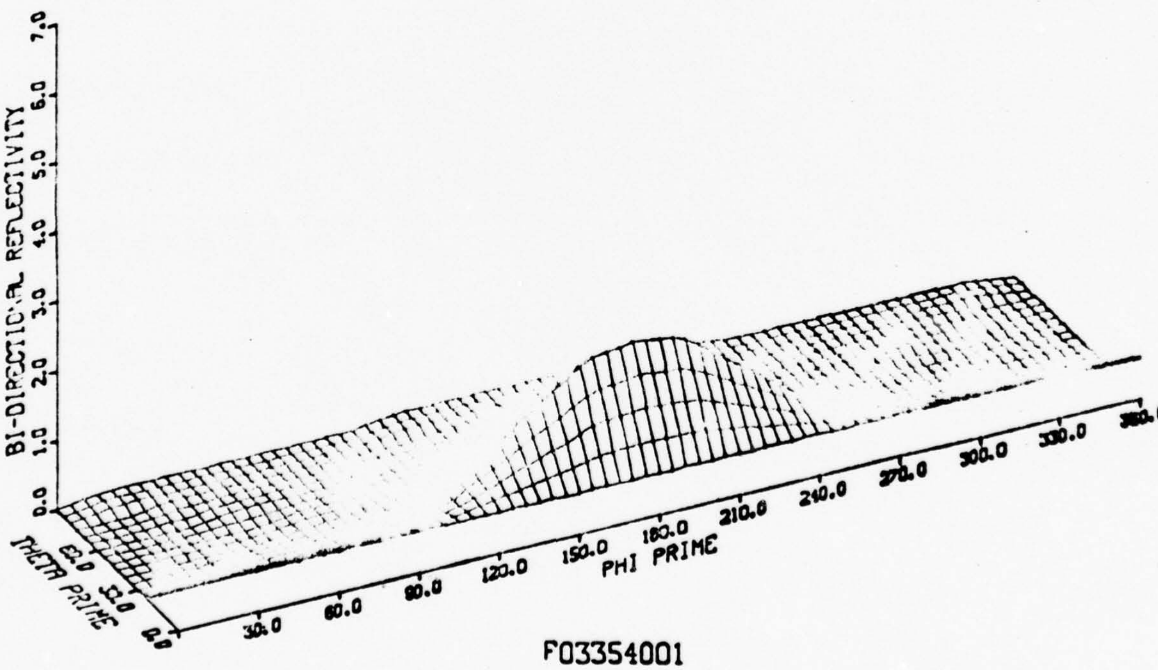


FIGURE IX-18 BIDIRECTIONAL REFLECTANCE

QUARTZ GROUND FRONT 30 MICRON GRIT, BACK POLISHED, 0.5 HOURS HF ETCH, NON-ENHANCED SILVER

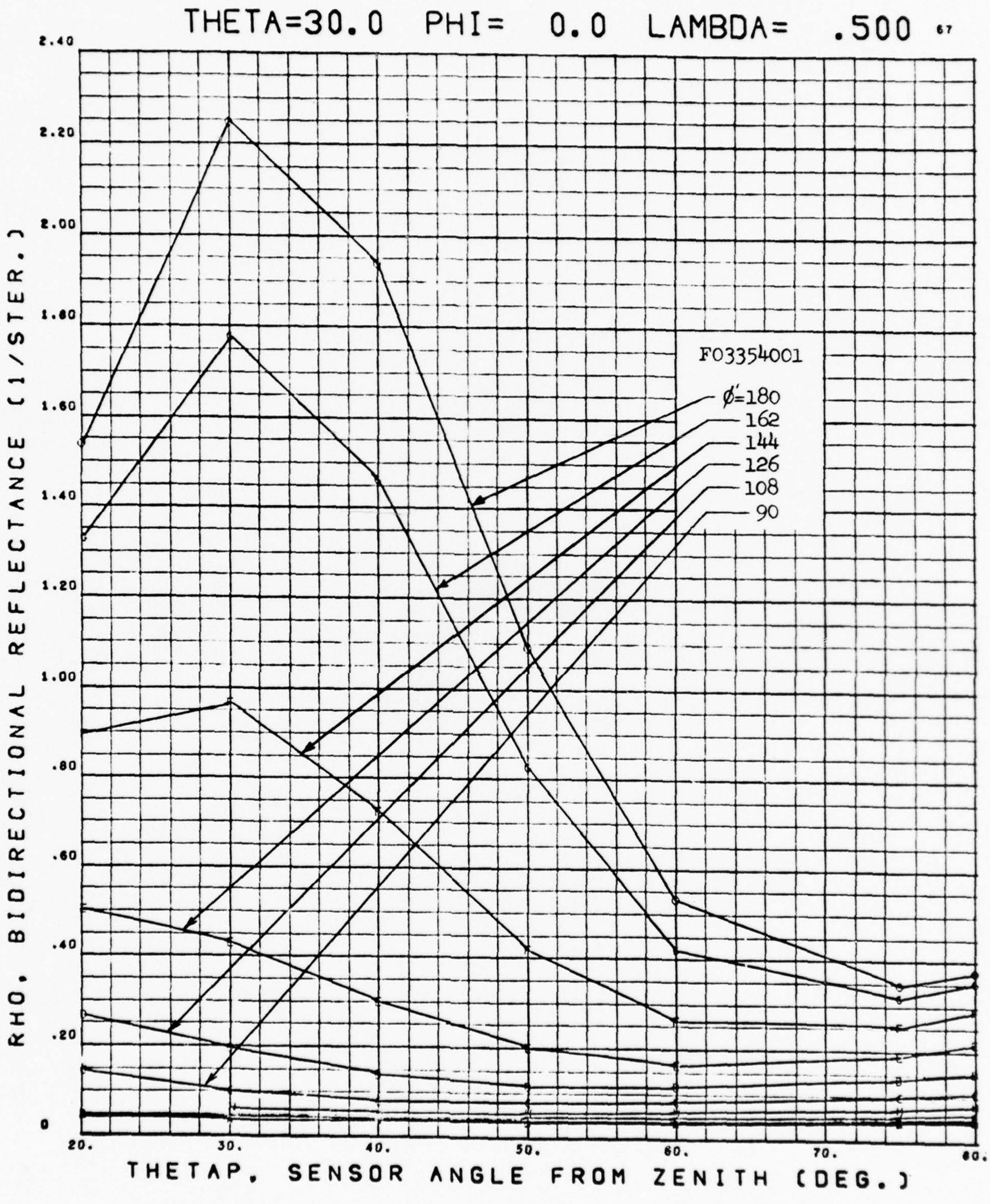


FIGURE IX-19 BIDIRECTIONAL REFLECTANCE

QUARTZ GROUND FRONT 30 MICRON GRIT, BACK POLISHED, 0.5 HOURS HF ETCH, NON-ENHANCED SILVER

.5 MICRONS THETA-30 DEGREES

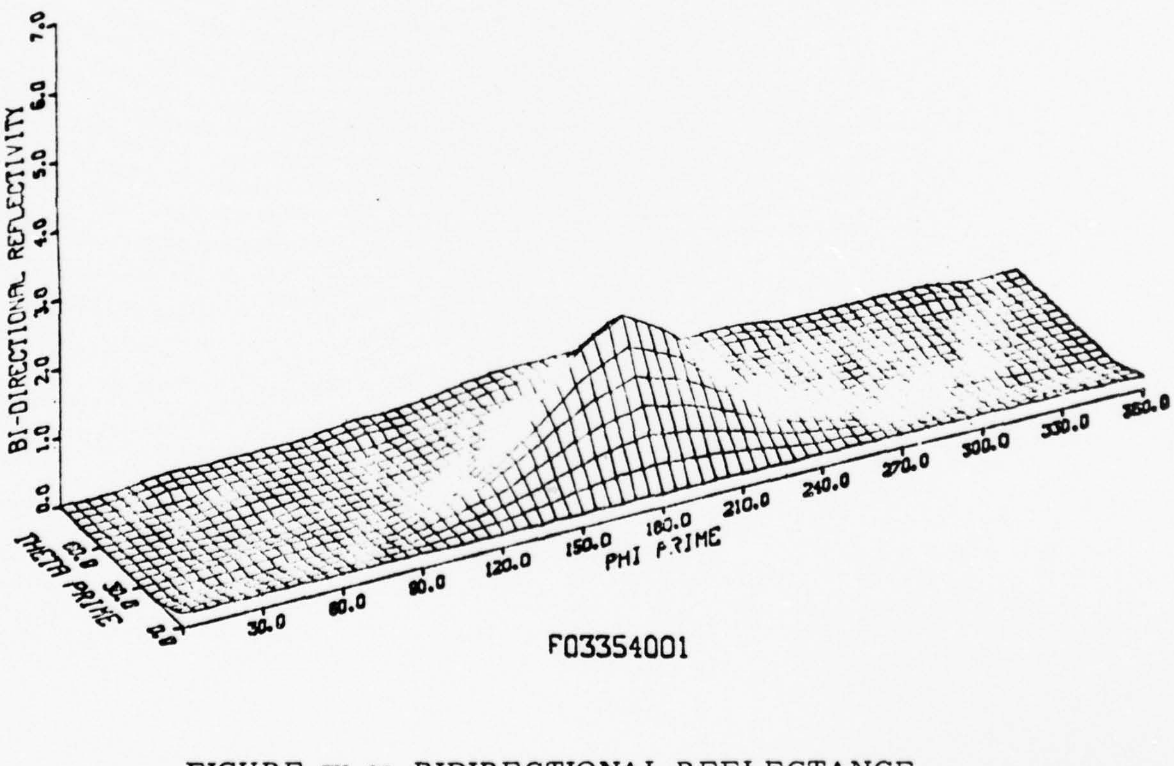


FIGURE IX-20 BIDIRECTIONAL REFLECTANCE

QUARTZ GROUND FRONT 30 MICRON GRIT, BACK POLISHED, 0.5 HOURS HF ETCH, NON-ENHANCED SILVER

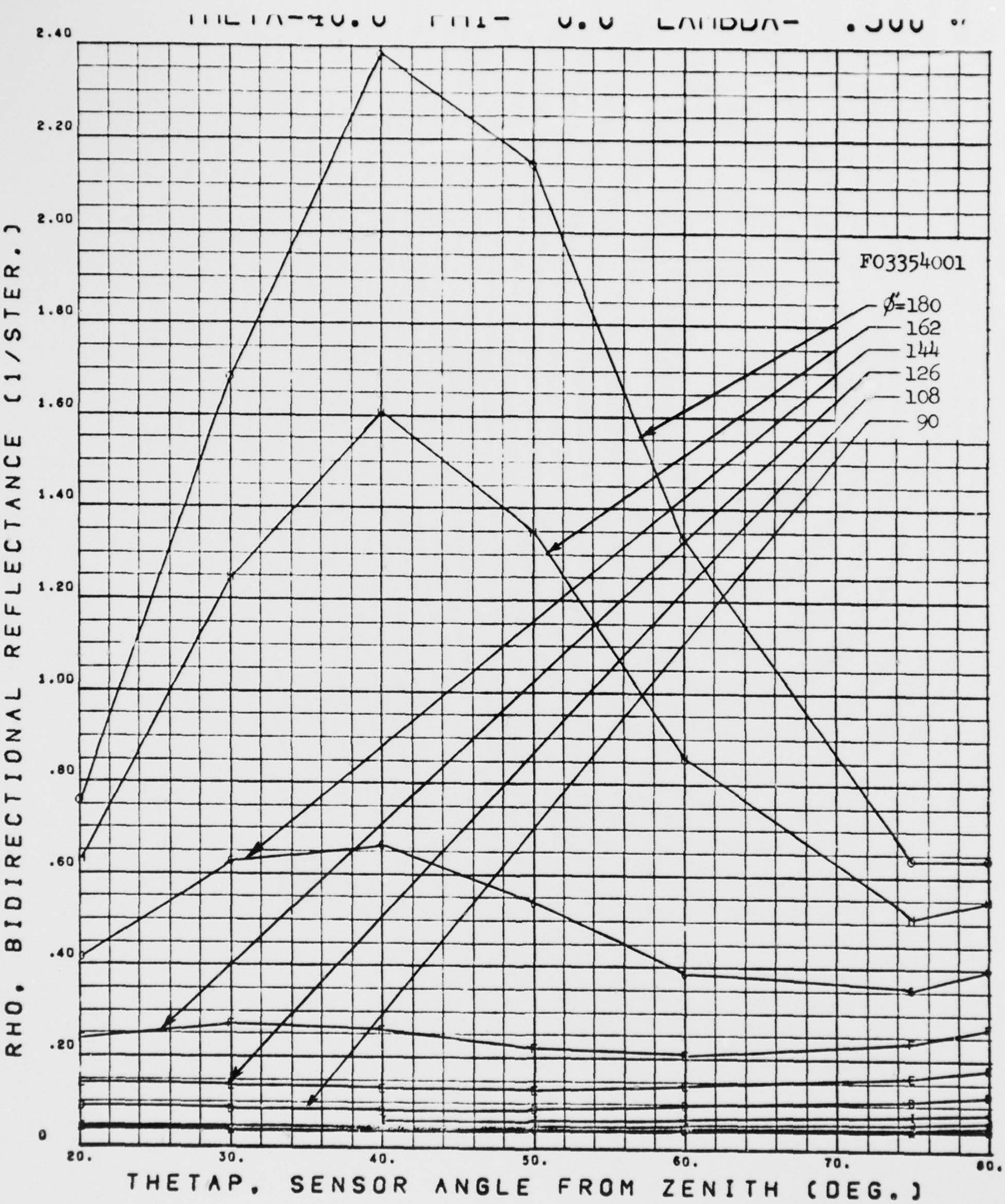


FIGURE IX-21 BIDIRECTIONAL REFLECTANCE

FUSED SILICA GROUND FRONT 30 MICRON GRIT, BACK POLISHED, 0.5 HOURS HF ETCH, NON-ENHANCED SILVER

.5 MICRONS THETA-40 DEGREES

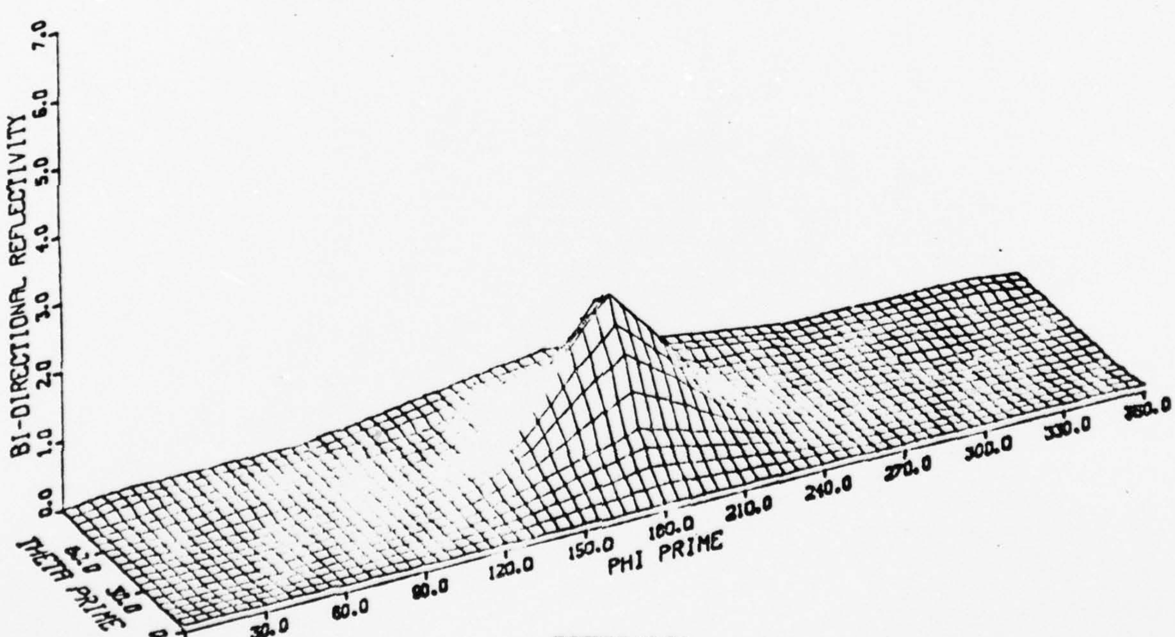


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FIGURE IX-22 BIDIRECTIONAL REFLECTANCE

FUSED SILICA GROUND FRONT 30 MICRON GRIT, BACK POLISHED, 0.5 HOURS HF ETCH, NON-ENHANCED SILVER

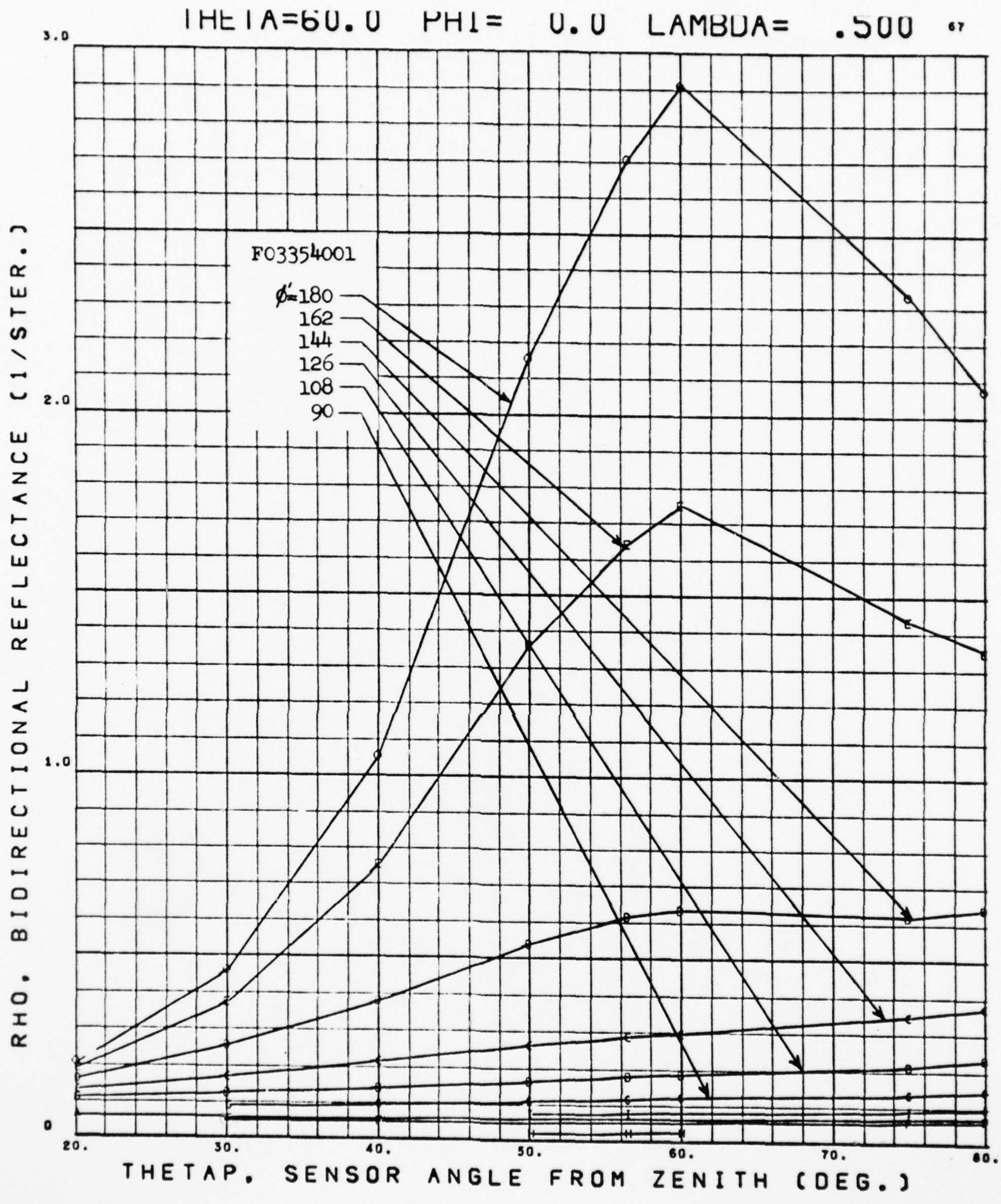
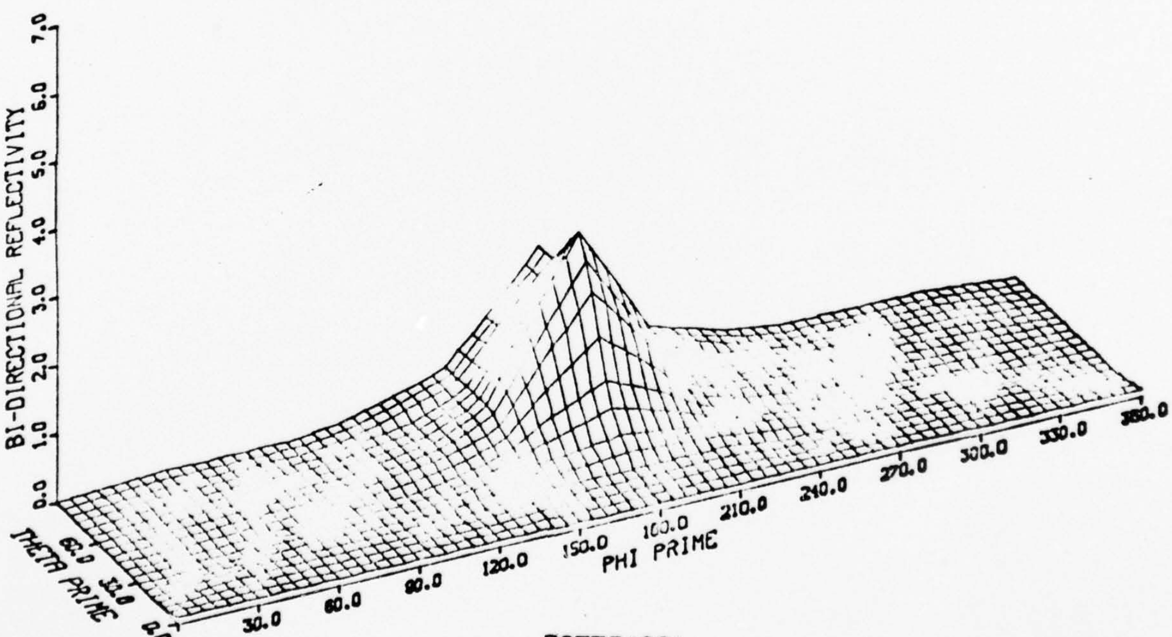


FIGURE IX-23 BIDIRECTIONAL REFLECTANCE

FUSED SILICA GROUND FRONT 30 MICRON GRIT, BACK POLISHED, 0.5 HOURS HF ETCH, NON-ENHANCED SILVER

.5 MICRONS   THETA=60 DEGREES



F03354001

FIGURE IX-24 BIDIRECTIONAL REFLECTANCE

FUSED SILICA GROUND FRONT 30 MICRON GRIT, BACK POLISHED, 0.5 HOURS HF ETCH, NON-ENHANCED SILVER

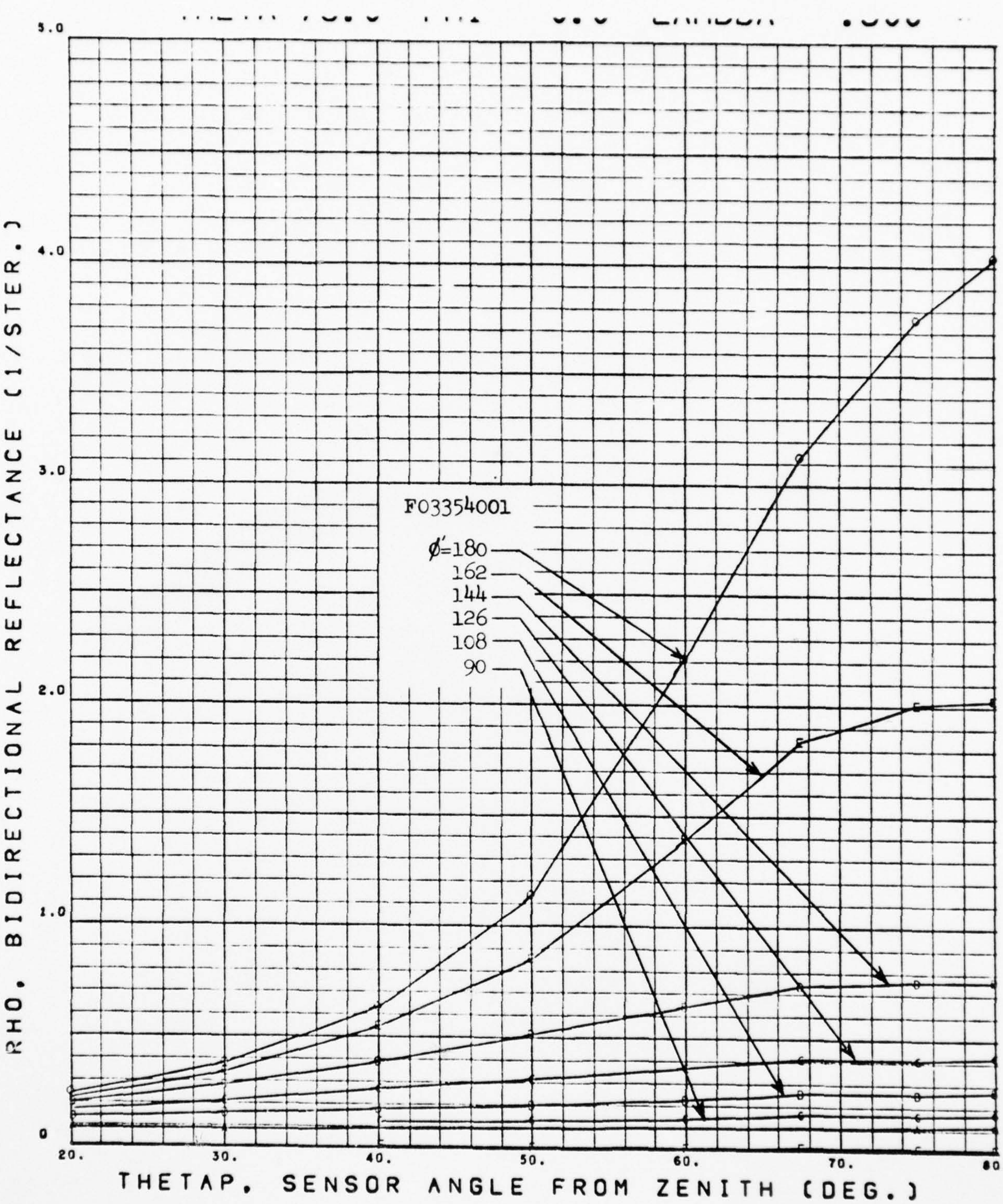


FIGURE IX-25 BIDIRECTIONAL REFLECTANCE

FUSED SILICA GROUND FRONT 30 MICRON GRIT, BACK POLISHED, 0.5 HOURS HF ETCH, NON-ENHANCED SILVER

.5 MICRONS THETA-75 DEGREES

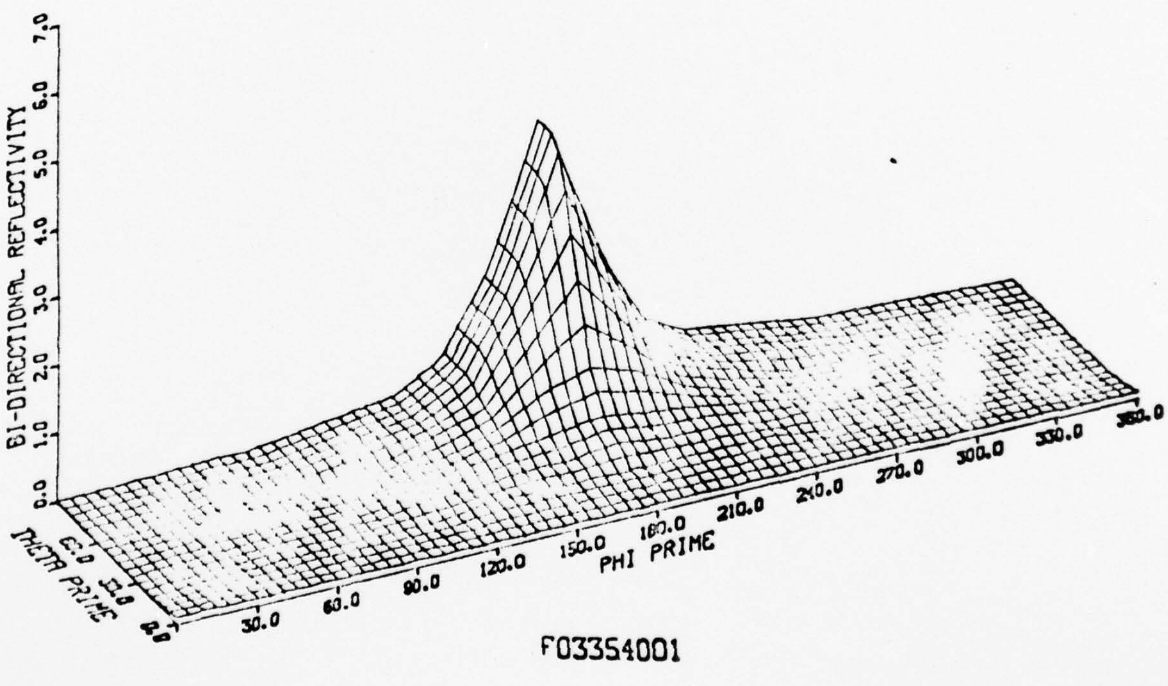


FIGURE IX-26 BIDIRECTIONAL REFLECTANCE

FUSED SILICA GROUND FRONT 30 MICRON GRIT, BACK POLISHED, 0.5 HOURS HF ETCH, NON-ENHANCED SILVER

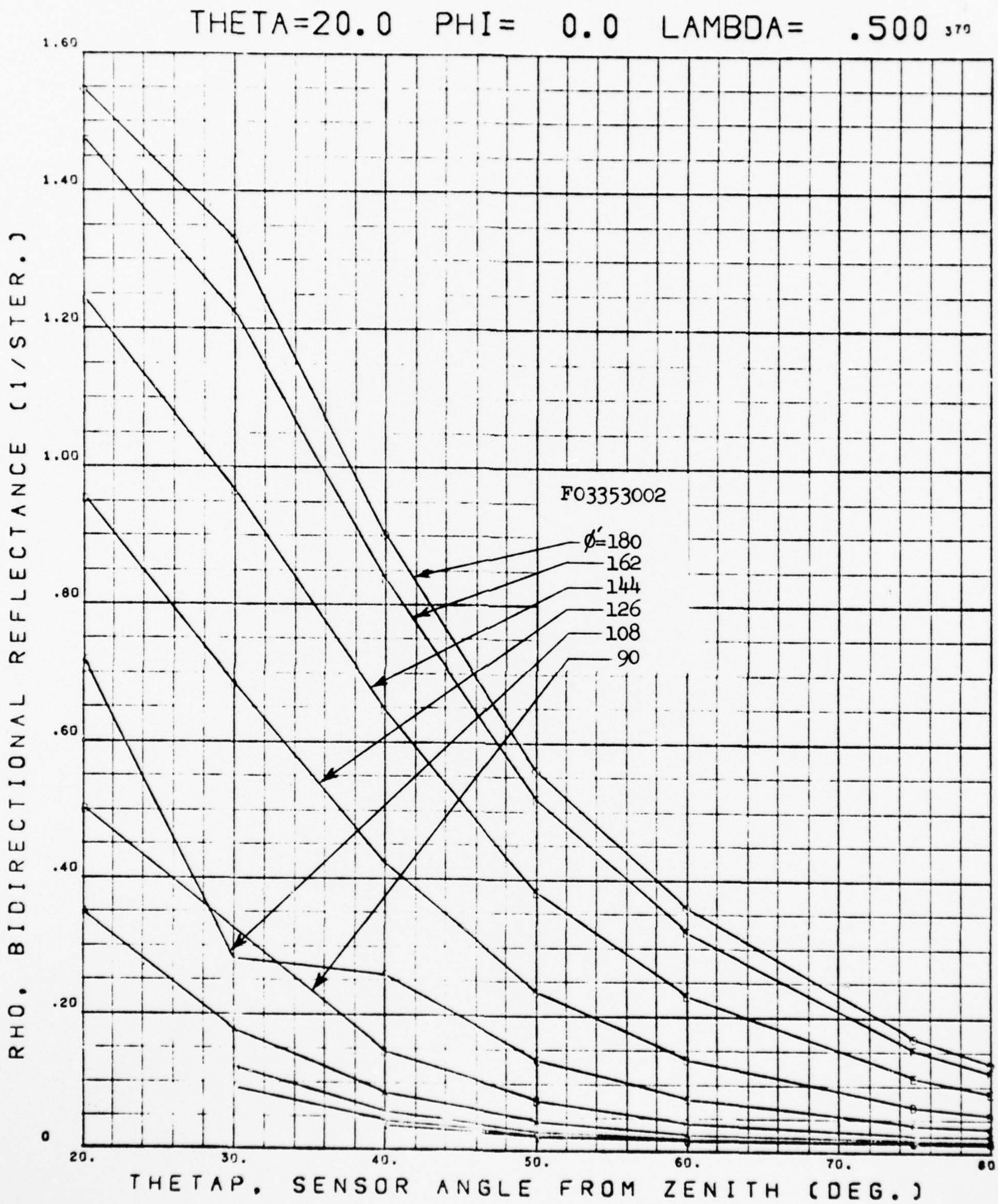


FIGURE IX-27 BIDIRECTIONAL REFLECTANCE

FUSED SILICA GROUND FRONT 3 MICRON GRIT, BACK
9 MICRON GRIT, 1.5 HOURS HF ETCH, ENHANCED SILVER

.5 MICRONS THETA=20 DEGREES

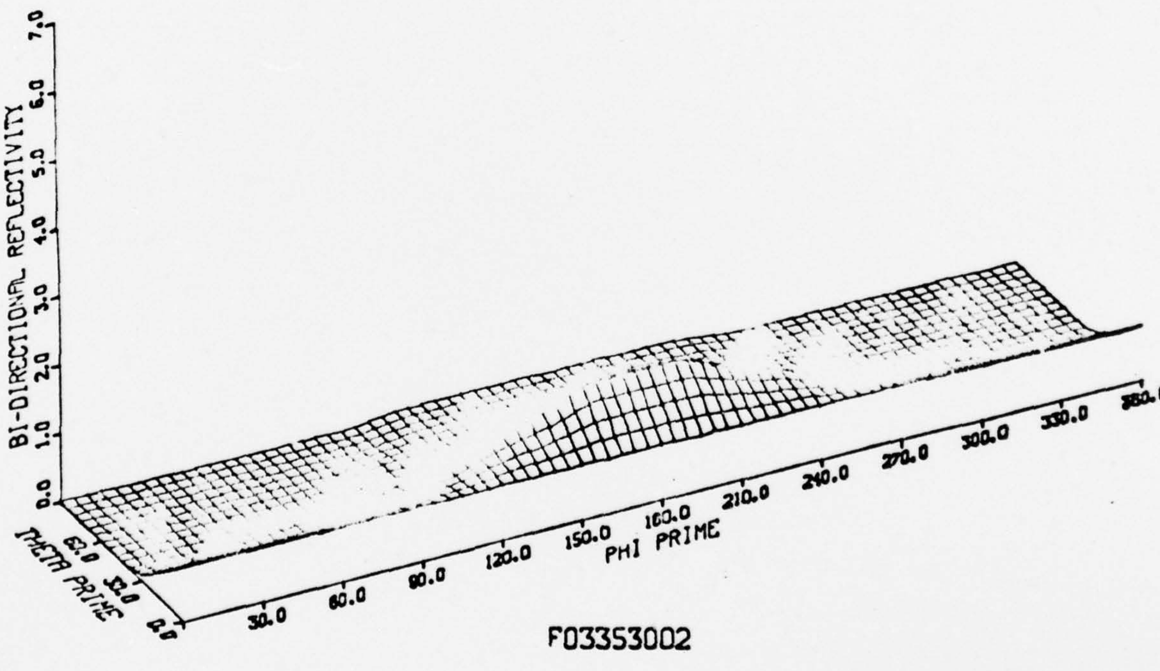


FIGURE IX-28 BIDIRECTIONAL REFLECTANCE

FUSED SILICA GROUND FRONT 3 MICRON GRIT, BACK 9 MICRON GRIT, 1.5 HOURS HF ETCH, ENHANCED SILVER

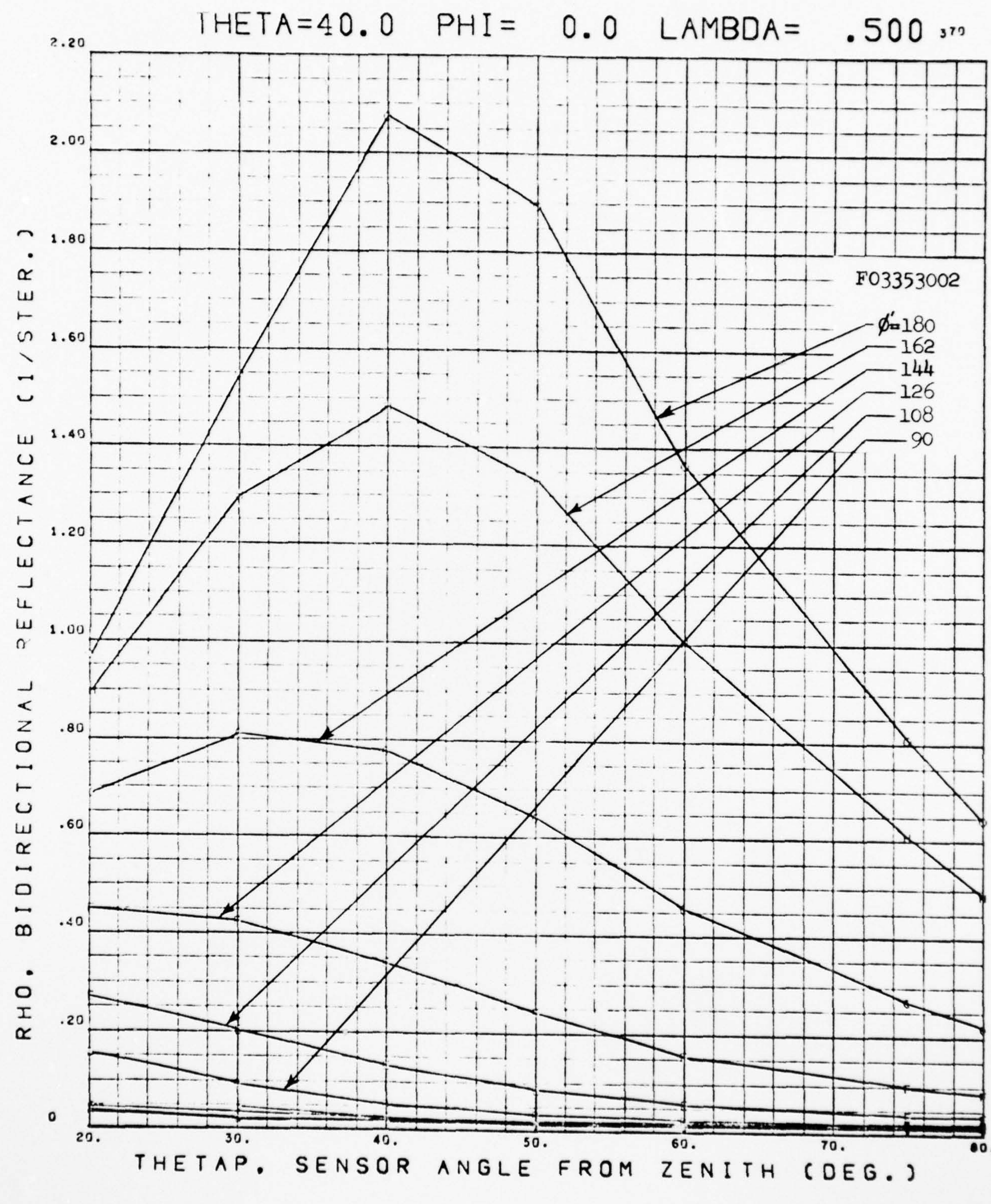


FIGURE IX-29 BIDIRECTIONAL REFLECTANCE

FUSED SILICA GROUND FRONT 3 MICRON GRIT, BACK 9 MICRON GRIT, 1.5 HOURS HF ETCH, ENHANCED SILVER

.5 MICRONS THETA=40 DEGREES

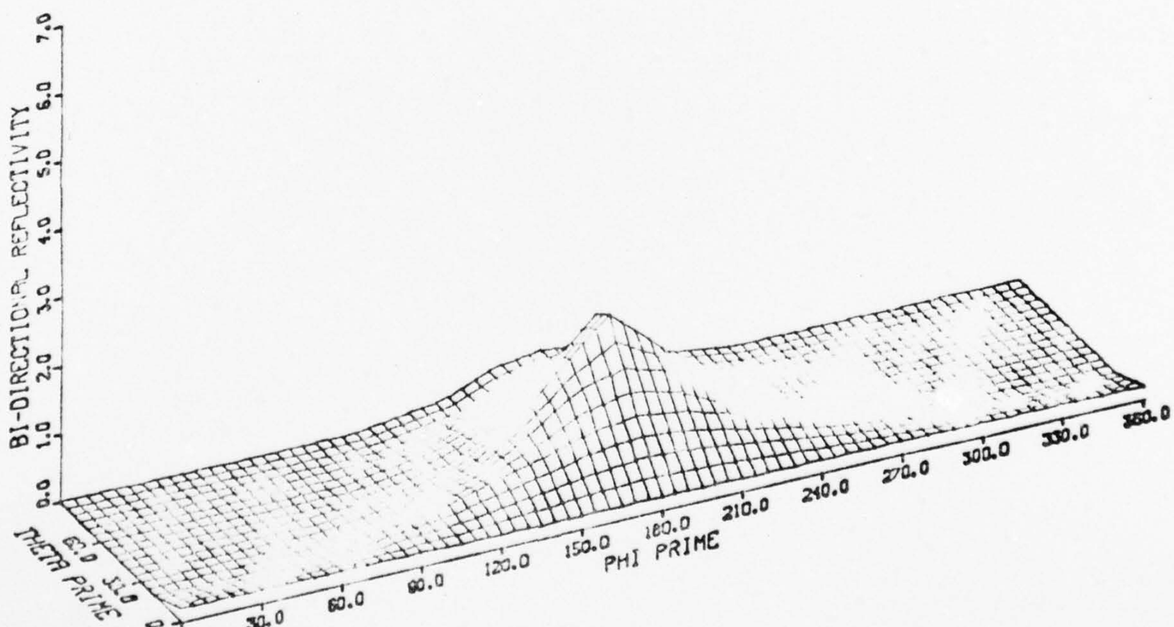


FIGURE IX-30 BIDIRECTIONAL REFLECTANCE

FUSED SILICA GROUND FRONT 3 MICRON GRIT, BACK 9 MICRON GRIT, 1.5 HOURS HF ETCH, ENHANCED SILVER

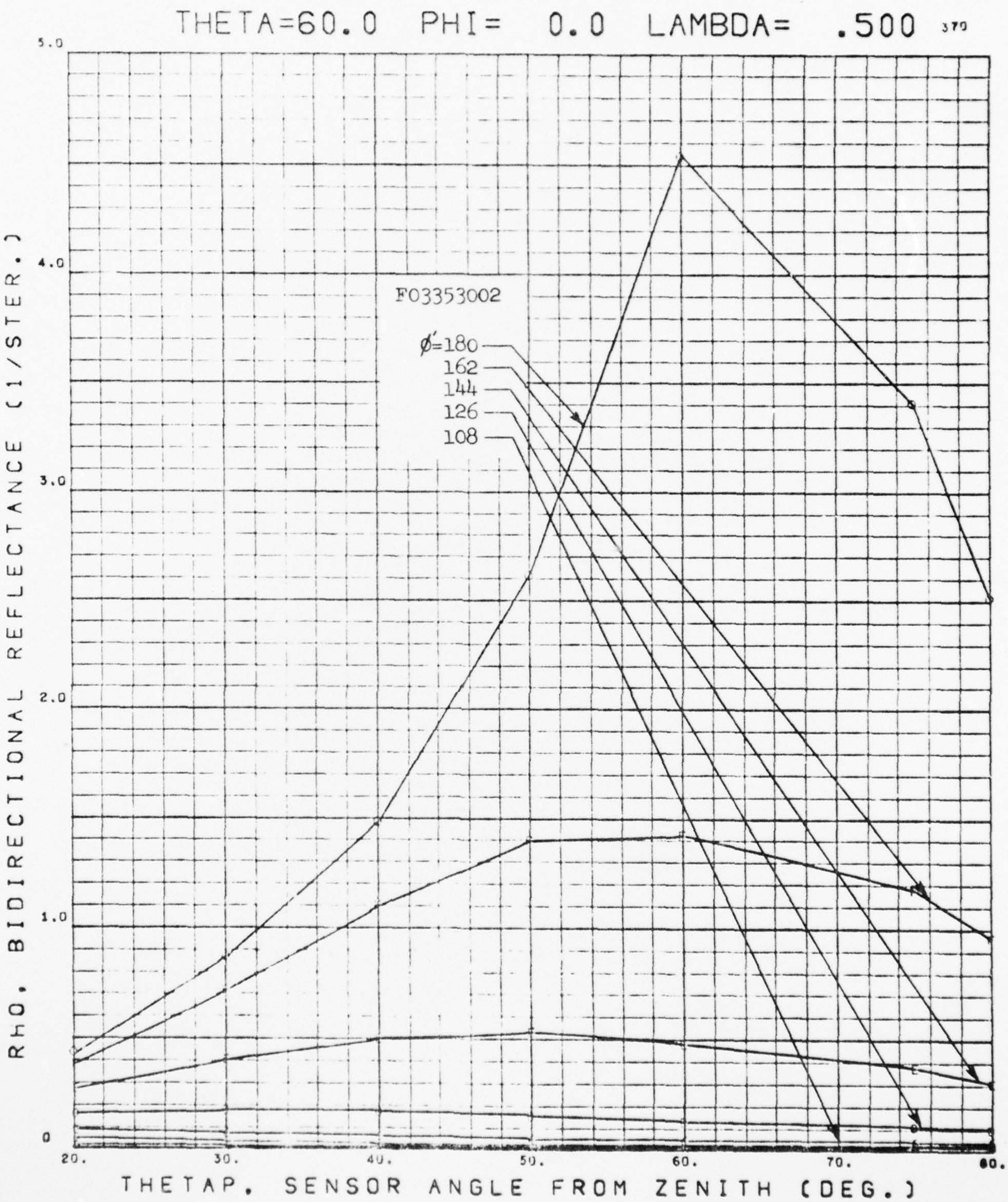


FIGURE IX-31 BIDIRECTIONAL REFLECTANCE

FUSED SILICA GROUND FRONT 3 MICRON GRIT, BACK 9 MICRON GRIT, 1.5 HOURS HF ETCH, ENHANCED SILVER

.5 MICRONS THETA-60 DEGREES

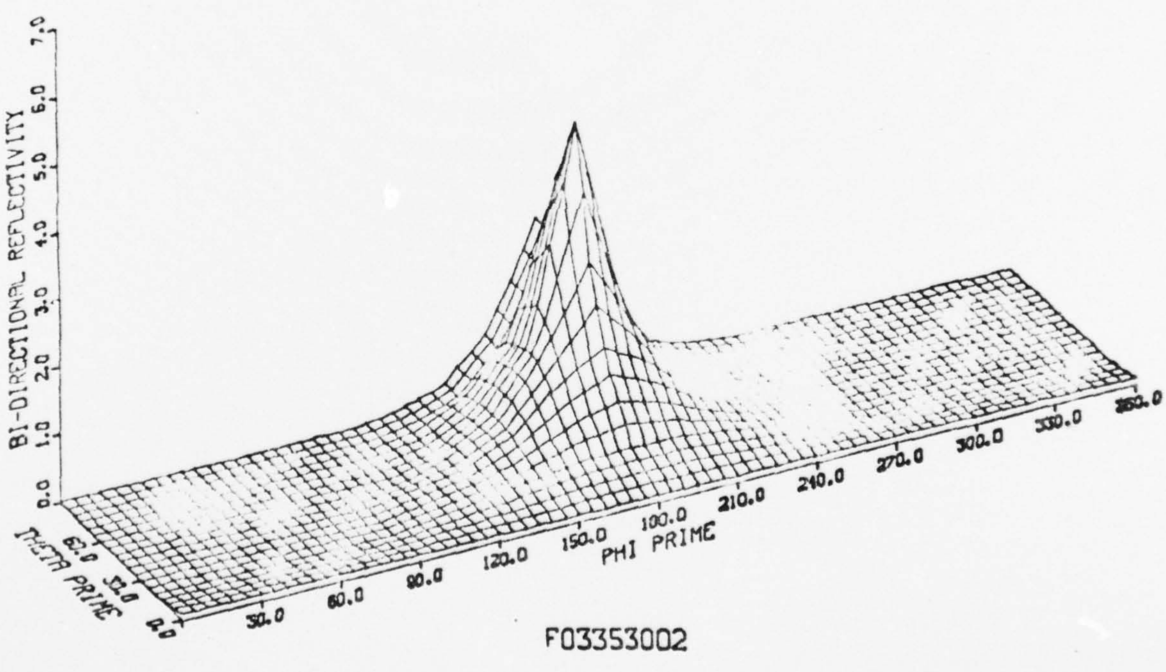


FIGURE IX-32 BIDIRECTIONAL REFLECTANCE

FUSED SILICA GROUND FRONT 3 MICRON GRIT, BACK 9 MICRON GRIT, 1.5 HOURS HF ETCH, ENHANCED SILVER

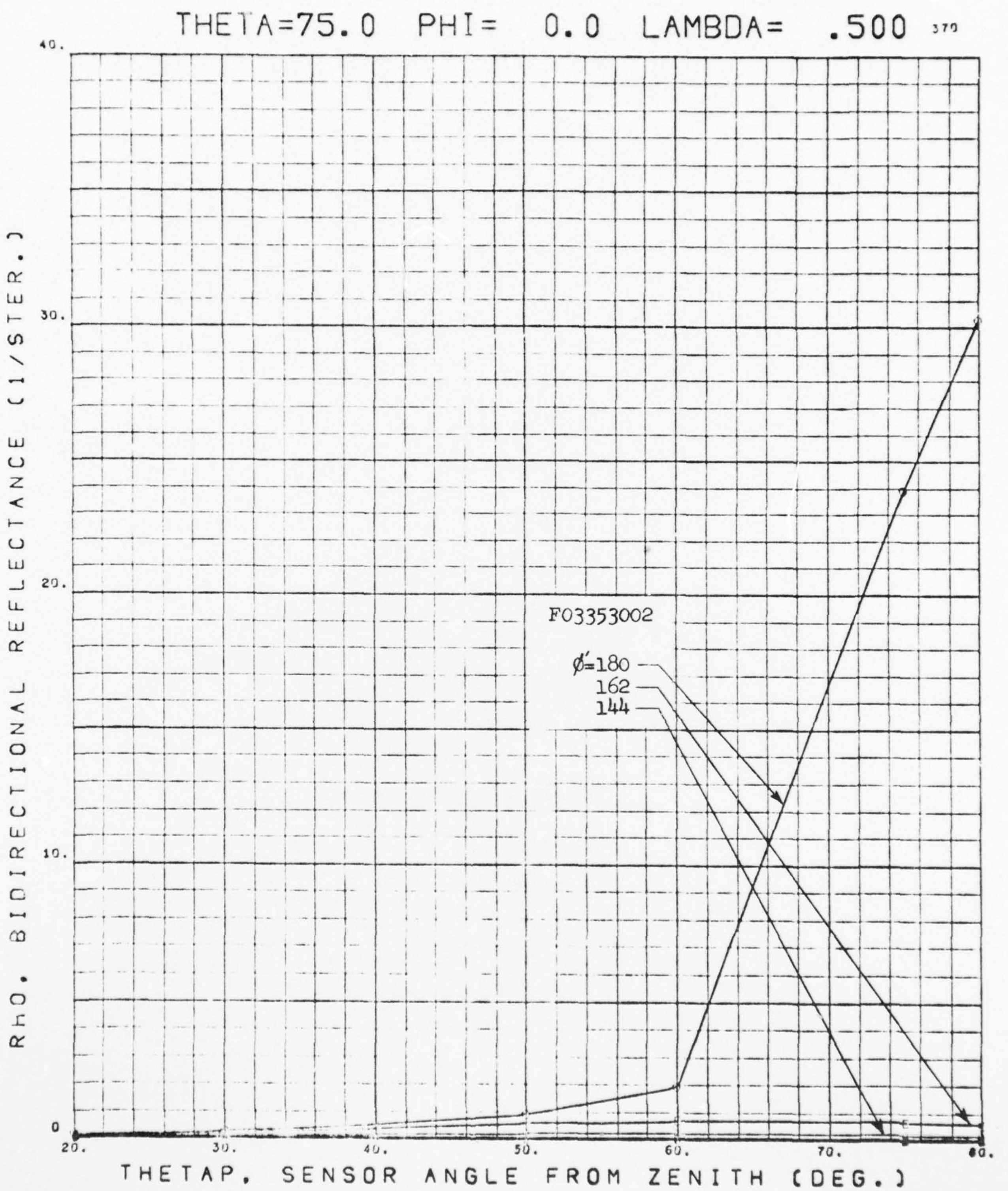


FIGURE IX-33 BIDIRECTIONAL REFLECTANCE

FUSED SILICA GROUND FRONT 3 MICRON GRIT, BACK
9 MICRON GRIT, 1.5 HOURS HF ETCH, ENHANCED SILVER

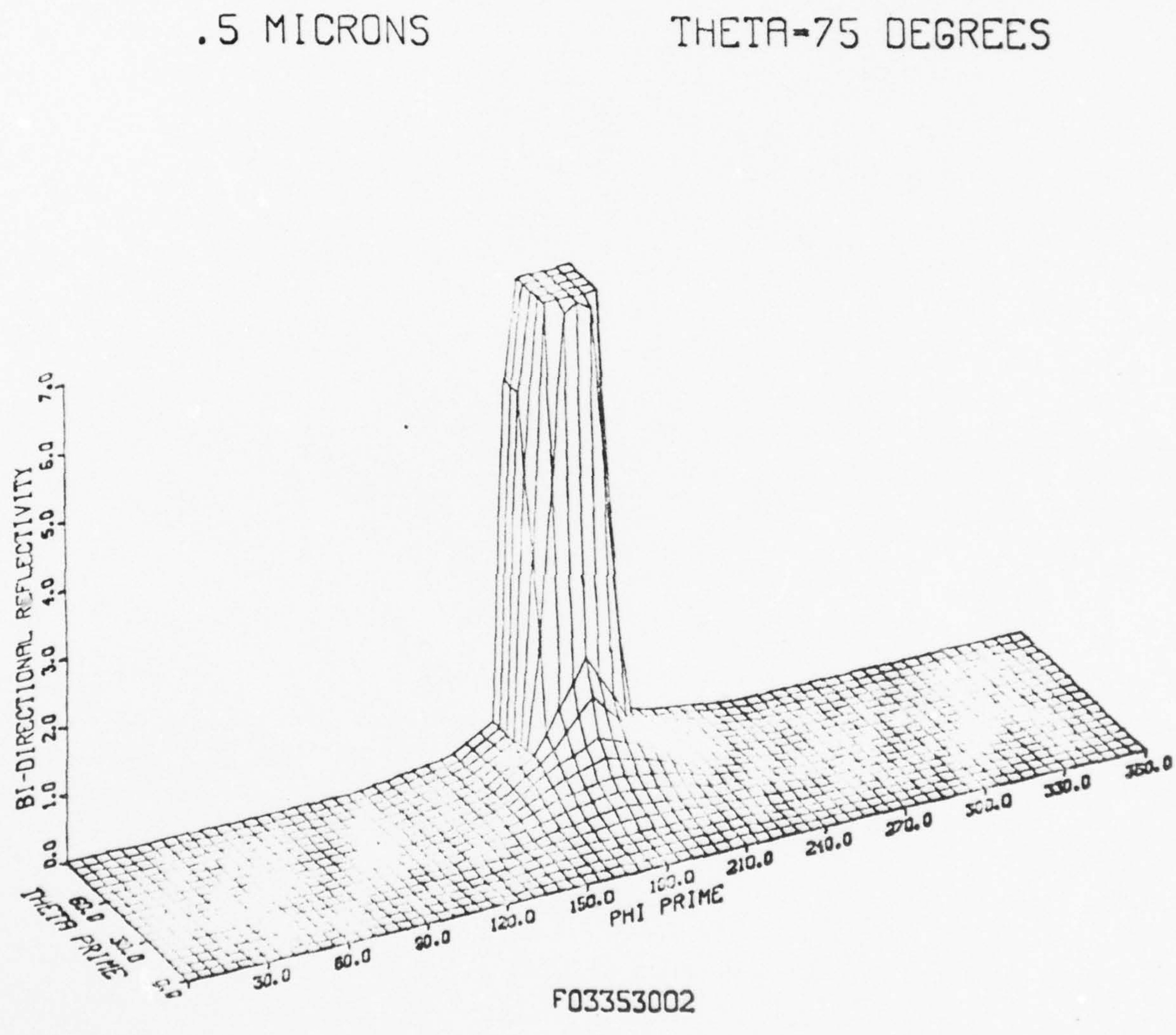


FIGURE IX-34 BIDIRECTIONAL REFLECTANCE

FUSED SILICA GROUND FRONT 3 MICRON GRIT, BACK 9 MICRON GRIT, 1.5 HOURS HF ETCH, ENHANCED SILVER

AD-A034 864 GENERAL DYNAMICS/CONVAIR SAN DIEGO CALIF F/G 22/2
SECOOND SURFACE THERMAL CONTROL MIRRORS FOR REFLECTION CONTROL.--ETC(U)
JAN 77 J T NEU, M F DORIAN F04701-74-C-0318
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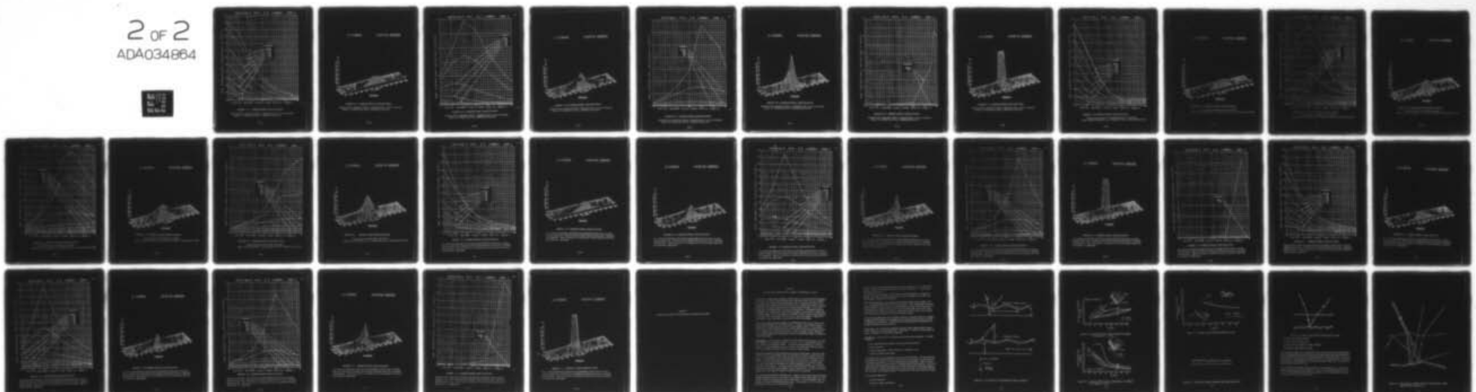

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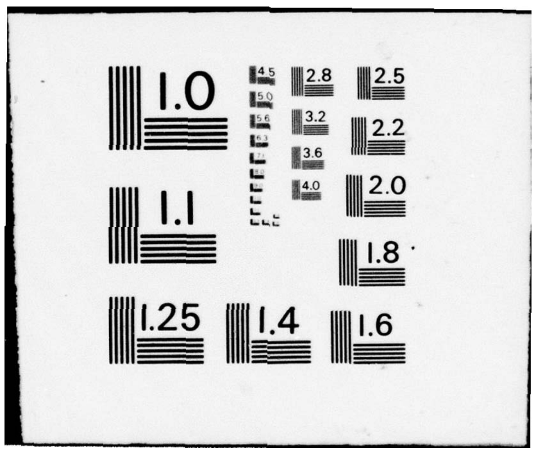
2 - 77


1.0
1.1
1.25
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5.0
5.6
6.3

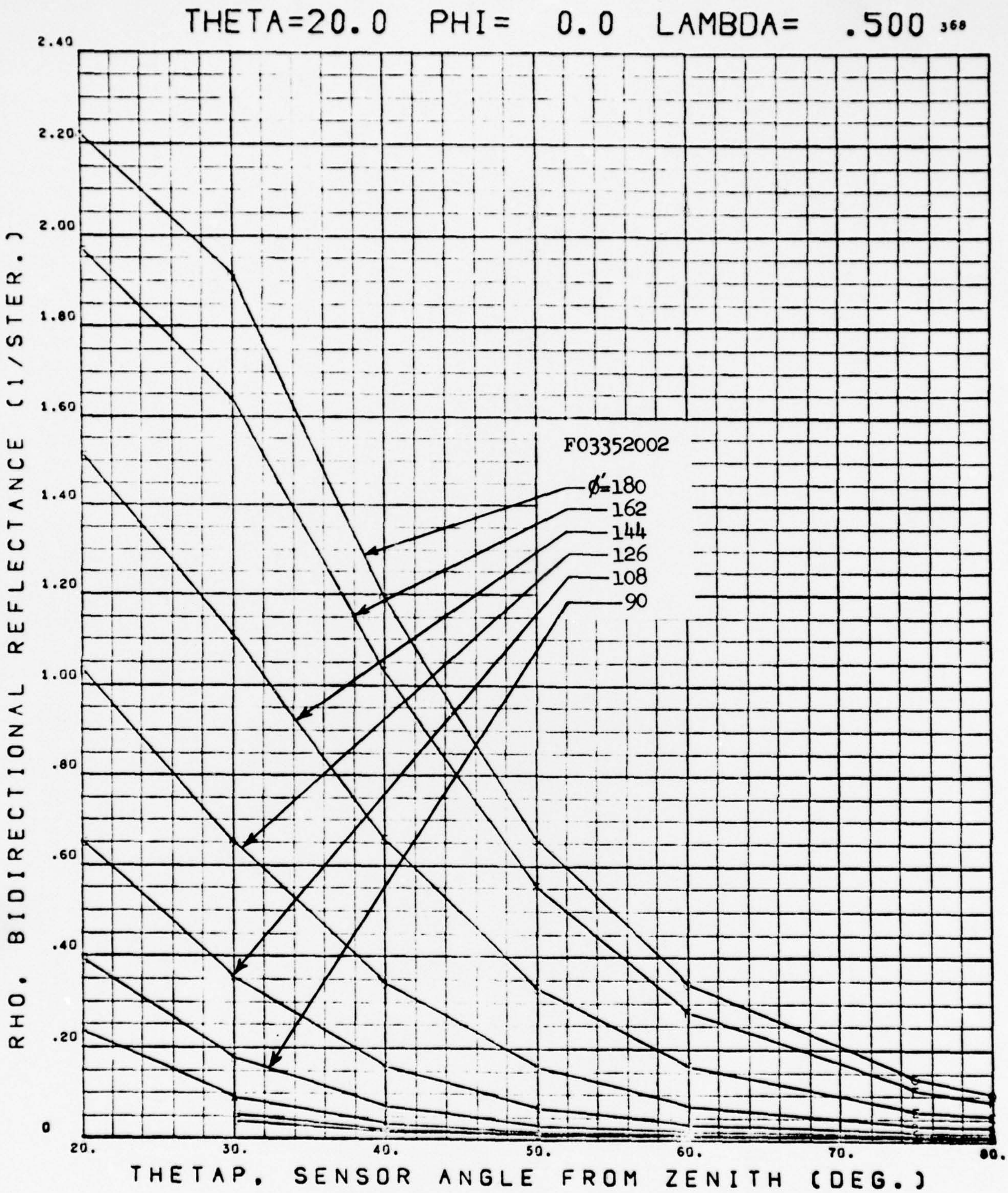
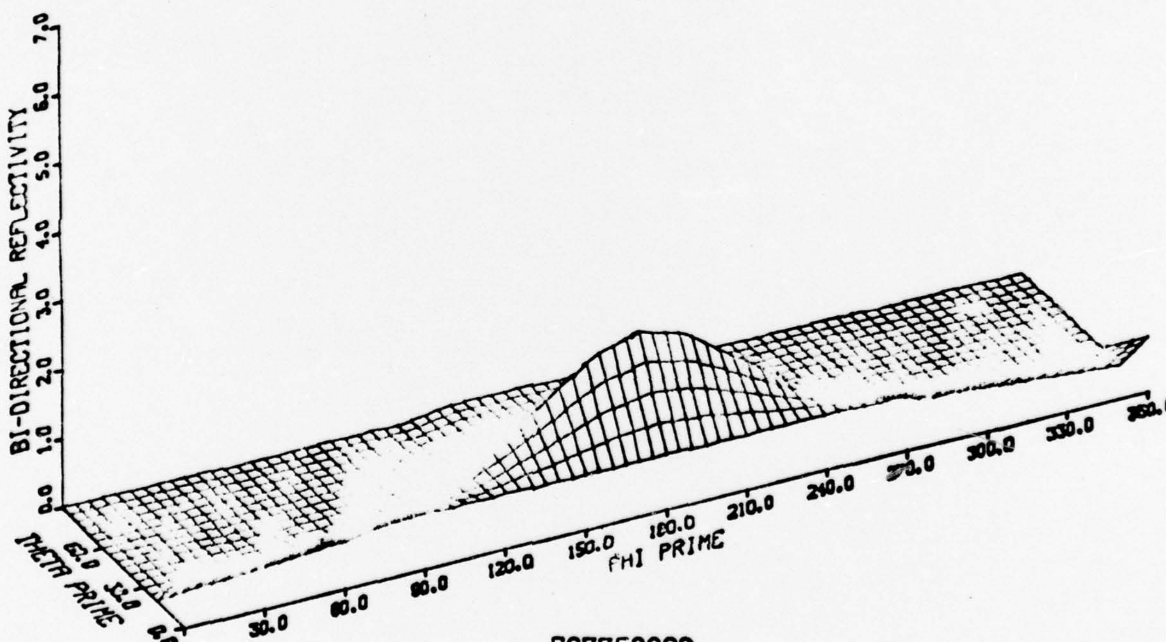


FIGURE IX-35 BIDIRECTIONAL REFLECTANCE

FUSED SILICA GROUND FRONT 3 MICRON GRIT, BACK 9 MICRON GRIT, 2.5 HOURS HF ETCH, ENHANCED SILVER

.5 MICRONS THETA-20 DEGREES



F03352002

FIGURE IX-36 BIDIRECTIONAL REFLECTANCE

FUSED SILICA GROUND FRONT 3 MICRON GRIT, BACK 9 MICRON GRIT, 2.5 HOURS HF ETCH, ENHANCED SILVER

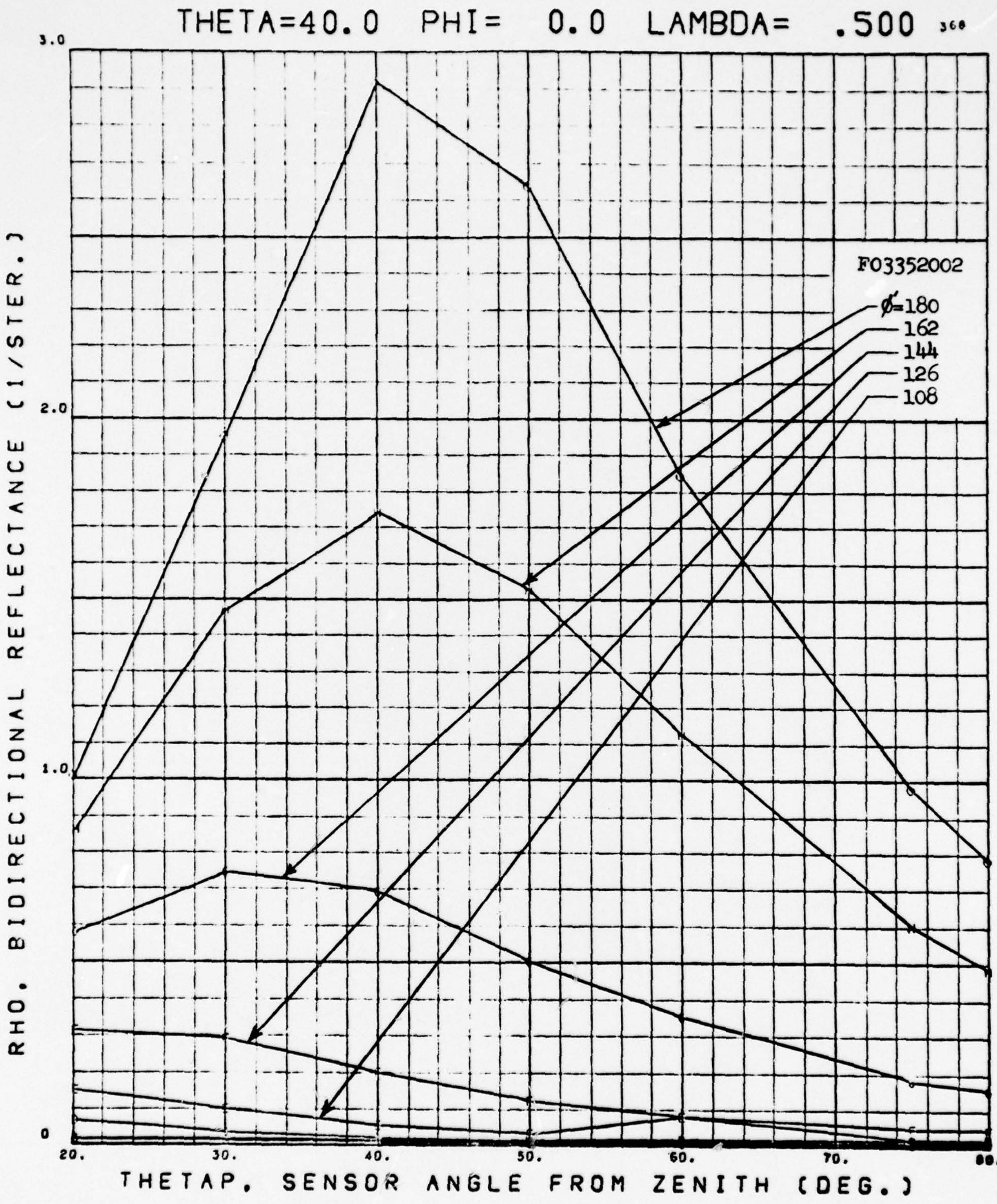


FIGURE IX-37 BIDIRECTIONAL REFLECTANCE

FUSED SILICA GROUND FRONT 3 MICRON GRIT, BACK 9 MICRON GRIT, 2.5 HOURS HF ETCH, ENHANCED SILVER

.5 MICRONS THETA-40 DEGREES

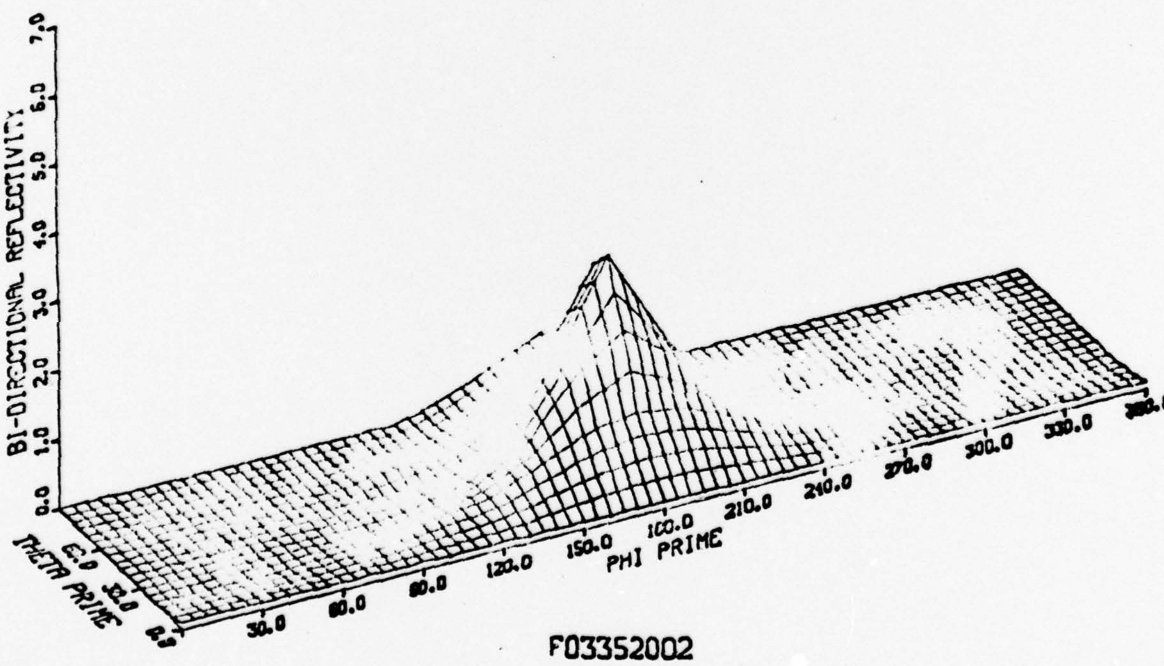


FIGURE IX-38 BIDIRECTIONAL REFLECTANCE

FUSED SILICA GROUND FRONT 3 MICRON GRIT, BACK 9 MICRON GRIT, 2.5 HOURS HF ETCH, ENHANCED SILVER

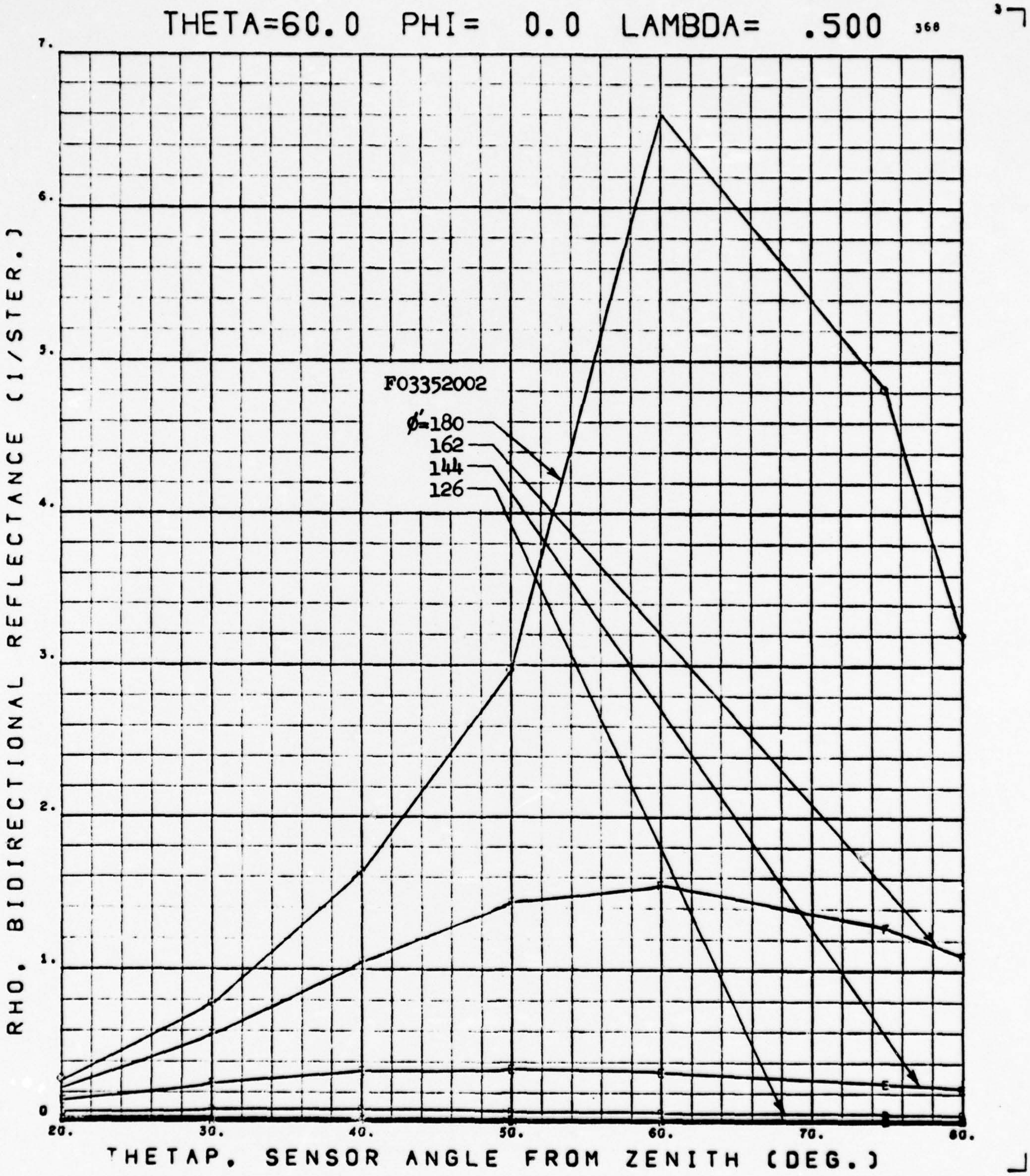


FIGURE IX-39 BIDIRECTIONAL REFLECTANCE

FUSED SILICA GROUND FRONT 3 MICRON GRIT, BACK 9 MICRON GRIT, 2.5 HOURS HF ETCH, ENHANCED SILVER

.5 MICRONS THETA-60 DEGREES

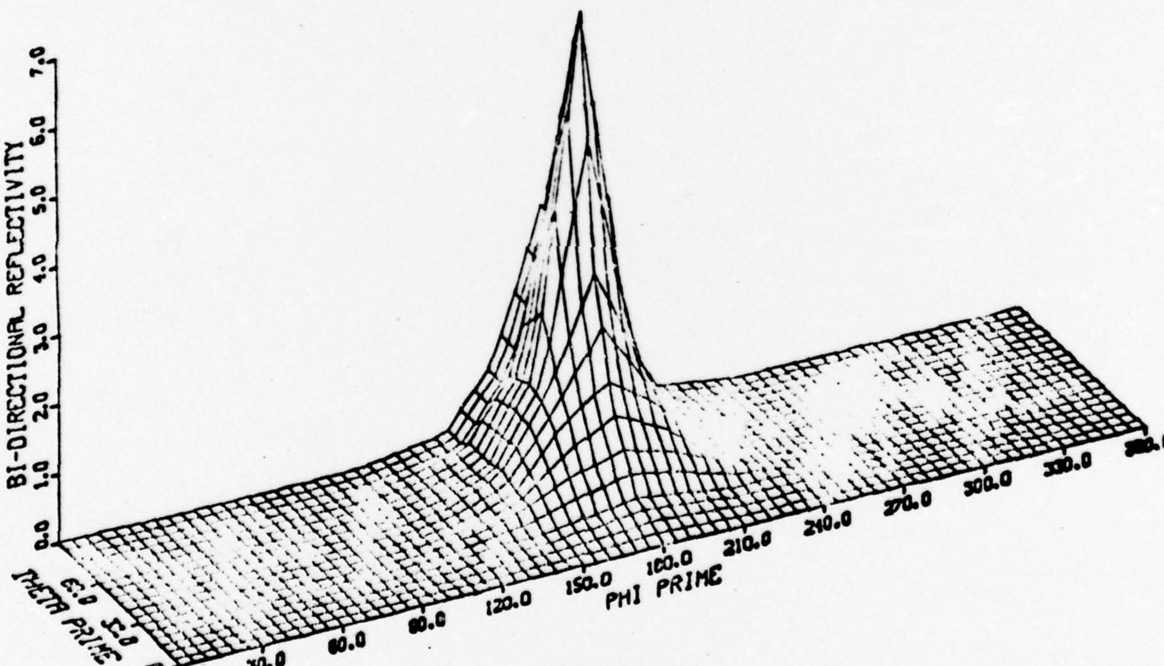


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FIGURE IX-40 BIDIRECTIONAL REFLECTANCE

FUSED SILICA GROUND FRONT 3 MICRON GRIT, BACK 9 MICRON GRIT, 2.5 HOURS HF ETCH, ENHANCED SILVER

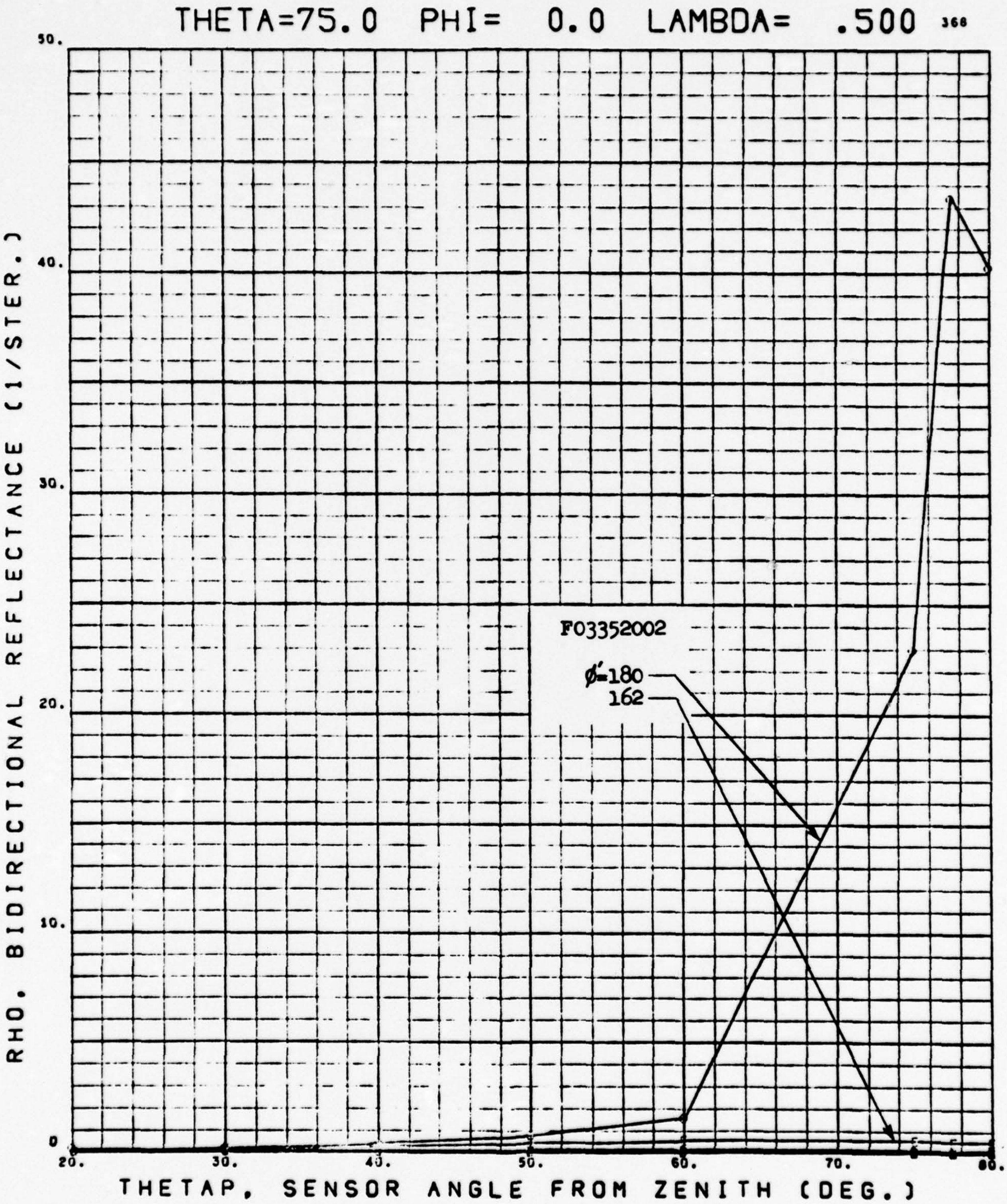

FIGURE IX-41 BIDIRECTIONAL REFLECTANCE

FUSED SILICA GROUND FRONT 3 MICRON GRIT, BACK 9 MICRON GRIT, 2.5 HOURS HF ETCH, ENHANCED SILVER

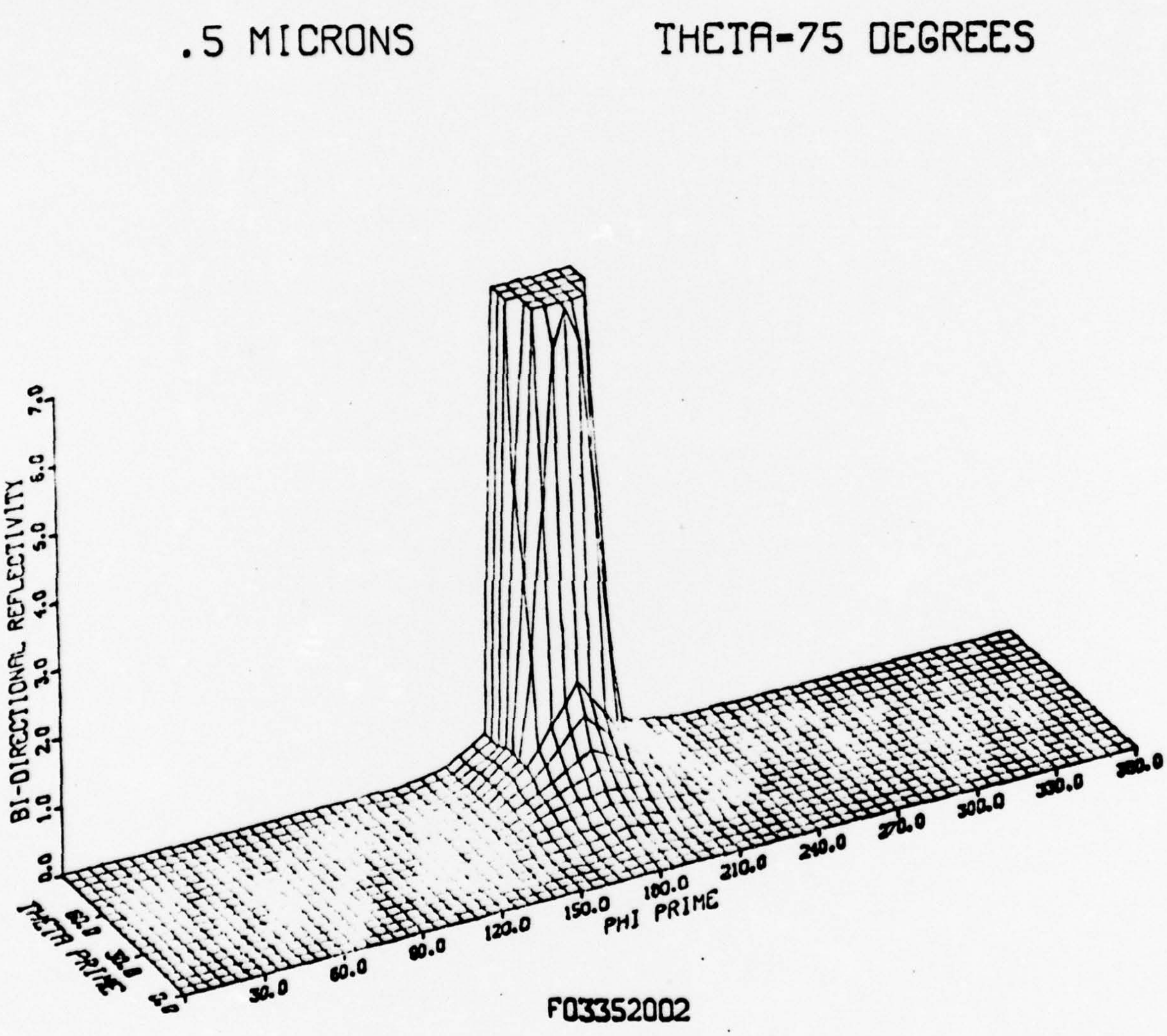

FIGURE IX-42 BIDIRECTIONAL REFLECTANCE

FUSED SILICA GROUND FRONT 3 MICRON GRIT, BACK 9 MICRON GRIT, 2.5 HOURS HF ETCH, ENHANCED SILVER

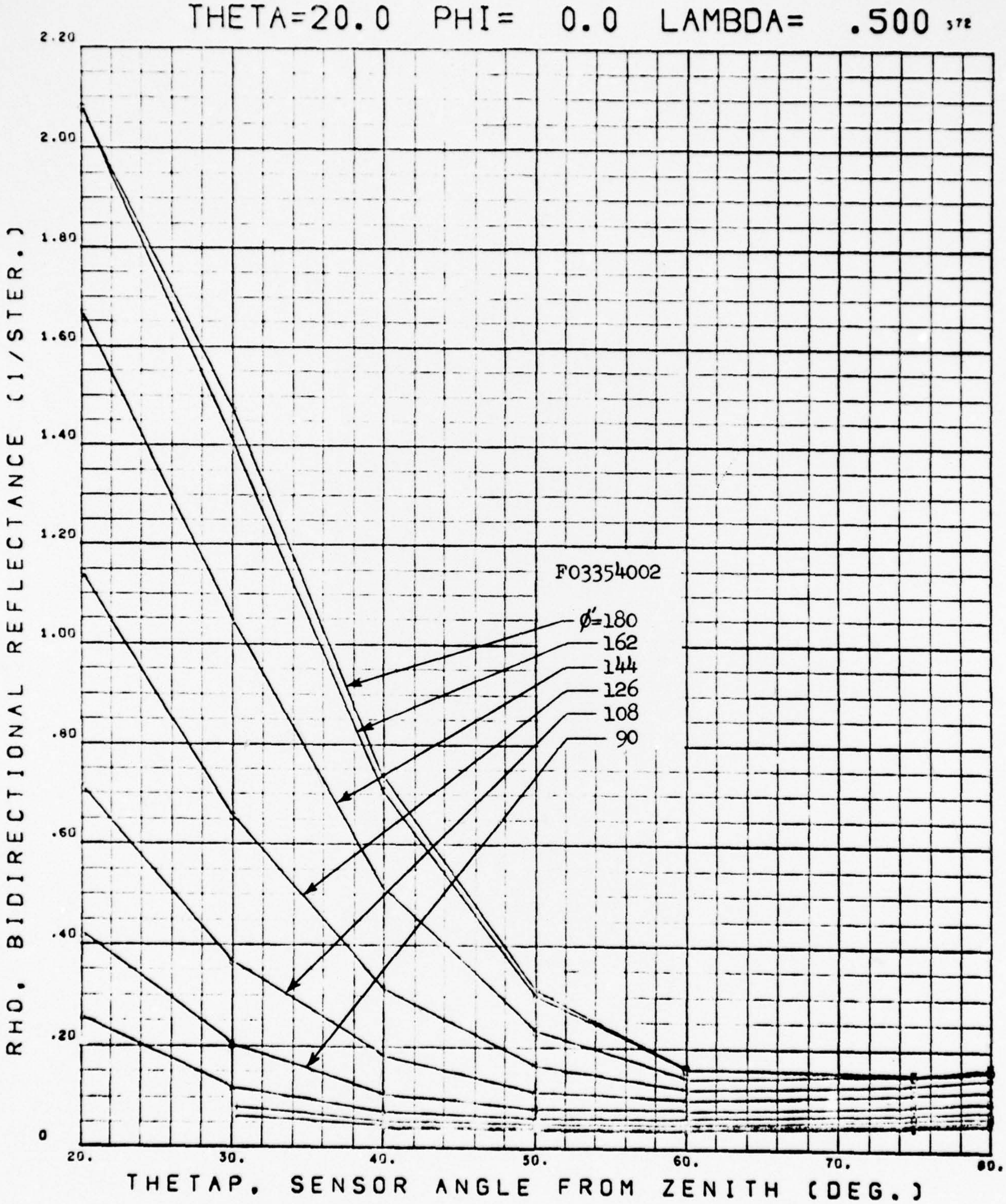

FIGURE IX-43 BIDIRECTIONAL REFLECTANCE

FUSED SILICA QUARTZ GROUND FRONT 30 MICRON GRIT, BACK POLISHED, 0.5 HOURS HF ETCH, ENHANCED SILVER

.5 MICRONS THETA-20 DEGREES

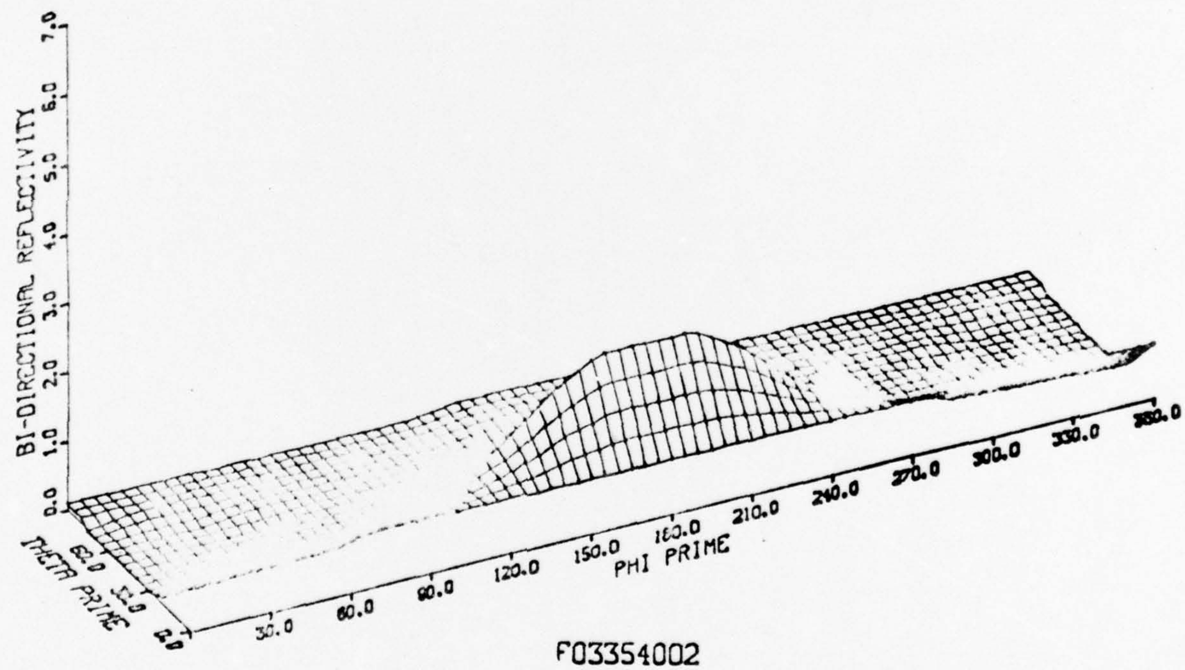

FIGURE IX-44 BIDIRECTIONAL REFLECTANCE

FUSED SILICA GROUND FRONT 30 MICRON
GRIT, BACK POLISHED, 0.5 HOURS HF ETCH, ENHANCED SILVER

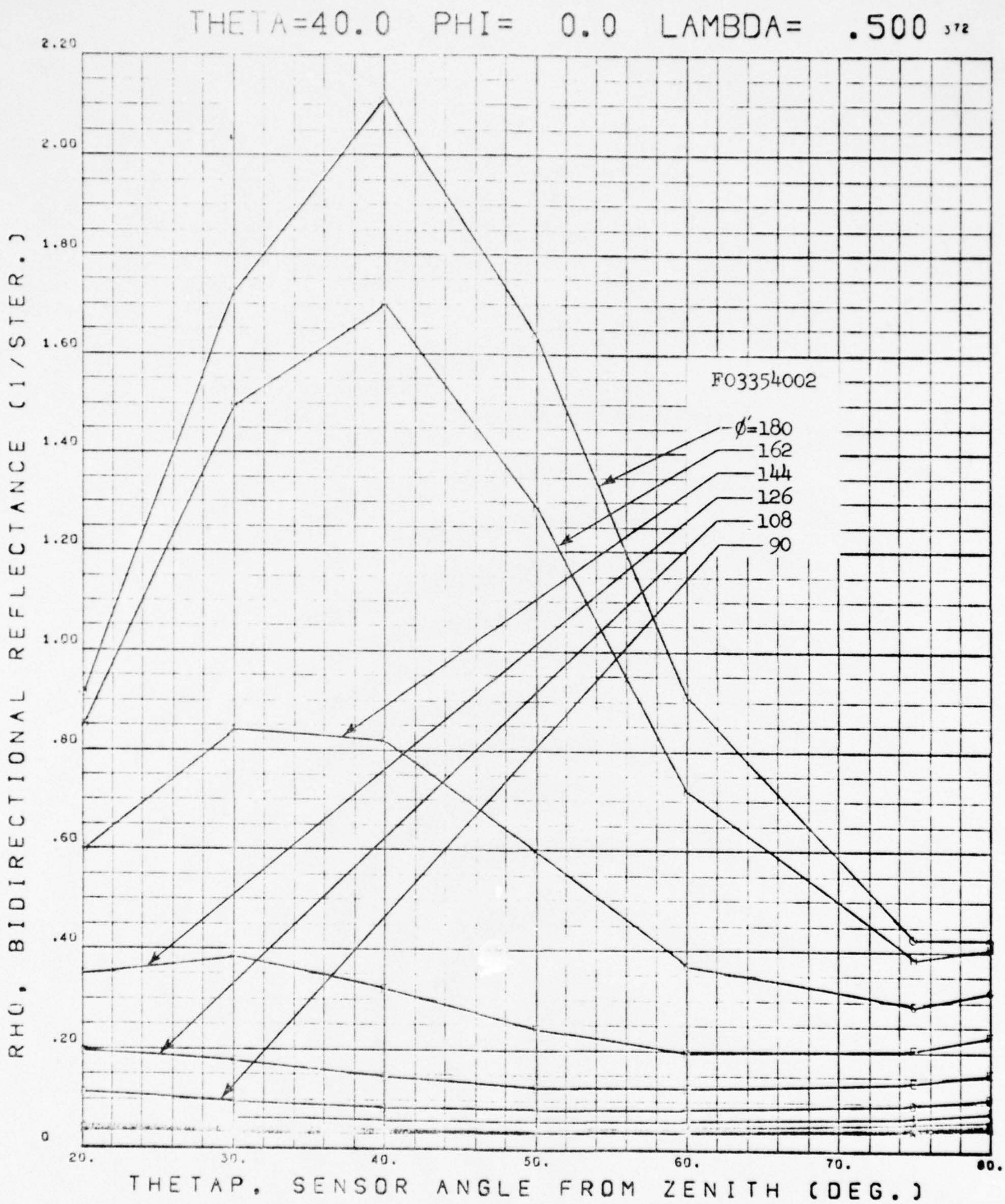

FIGURE IX-45 BIDIRECTIONAL REFLECTANCE

FUSED SILICA GROUND FRONT 30 MICRON GRIT, BACK POLISHED, 0.5 HOURS HF ETCH, ENHANCED SILVER

.5 MICRONS THETA-40 DEGREES

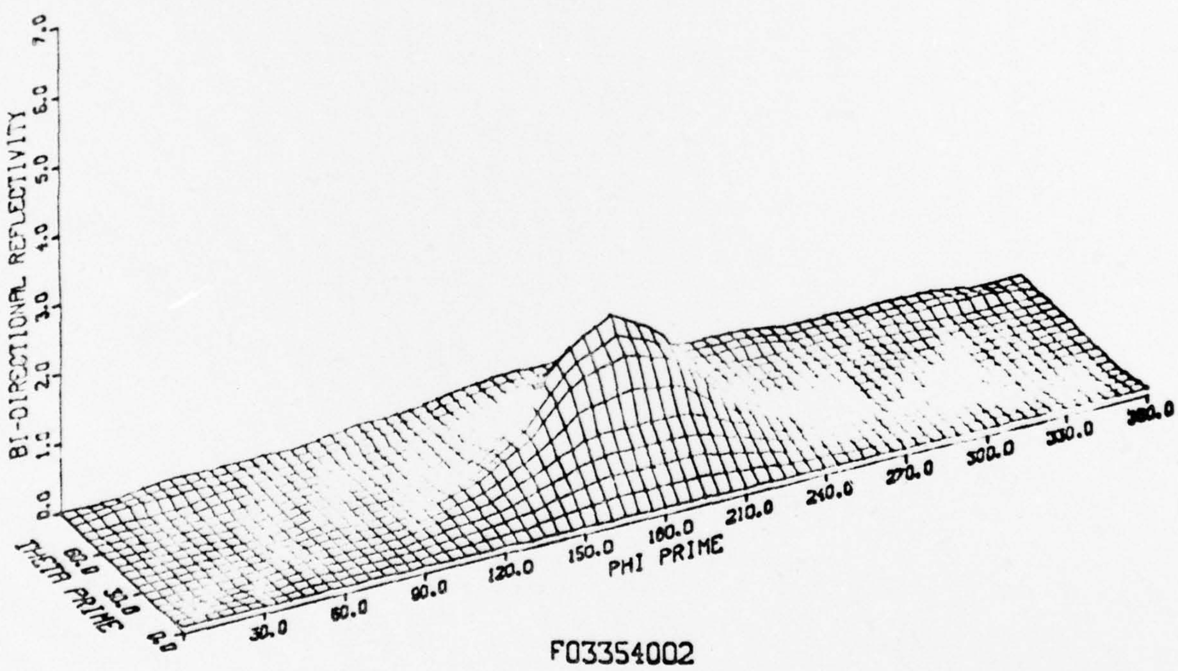

FIGURE IX-46 BIDIRECTIONAL REFLECTANCE

FUSED SILICA GROUND FRONT 30 MICRON GRIT, BACK POLISHED, 0.5 HOURS HF ETCH, ENHANCED SILVER

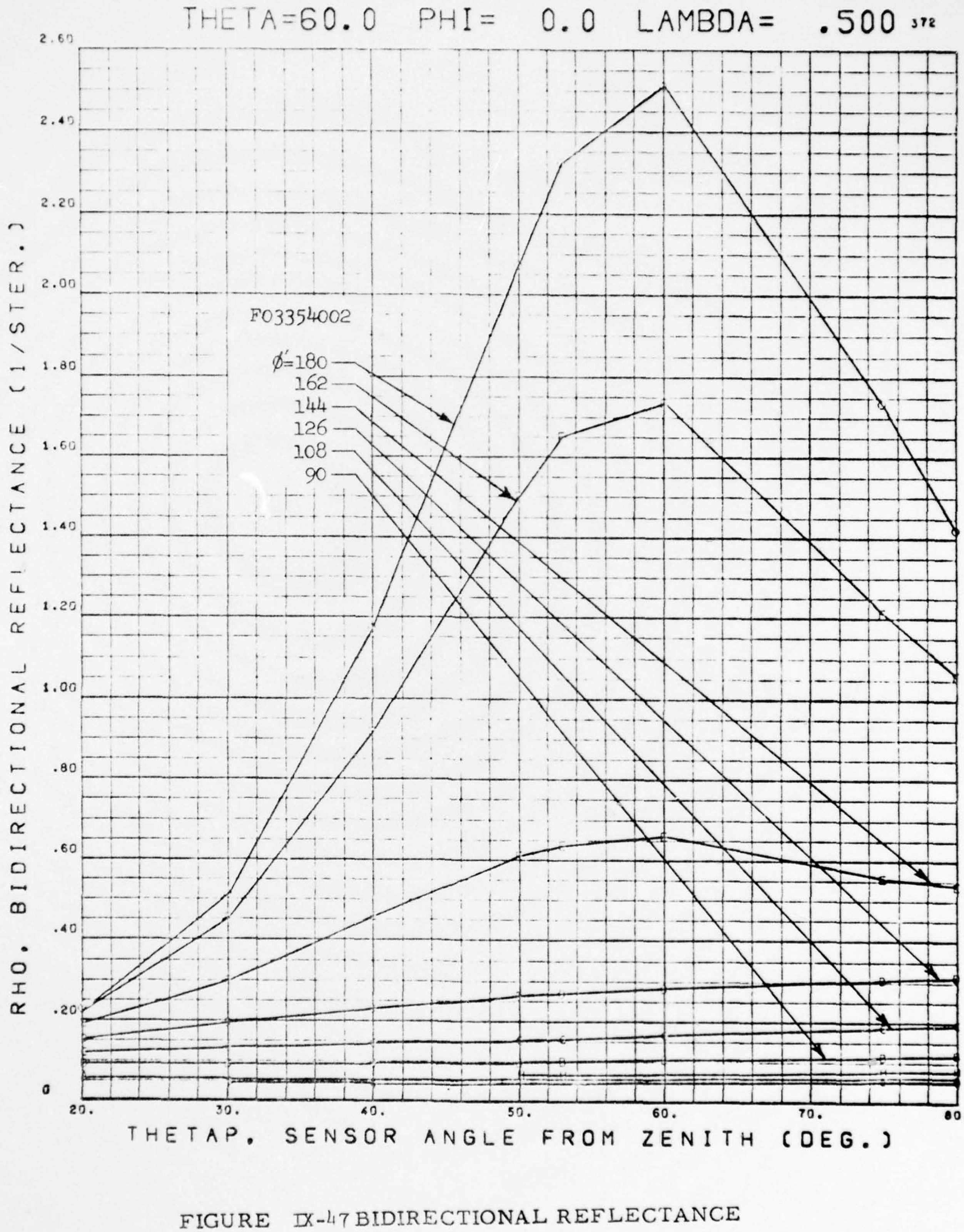

FIGURE IX-47 BIDIRECTIONAL REFLECTANCE

FUSED SILICA GROUND FRONT 30 MICRON GRIT, BACK POLISHED, 0.5 HOURS HF ETCH, ENHANCED SILVER

.5 MICRONS THETA=60 DEGREES

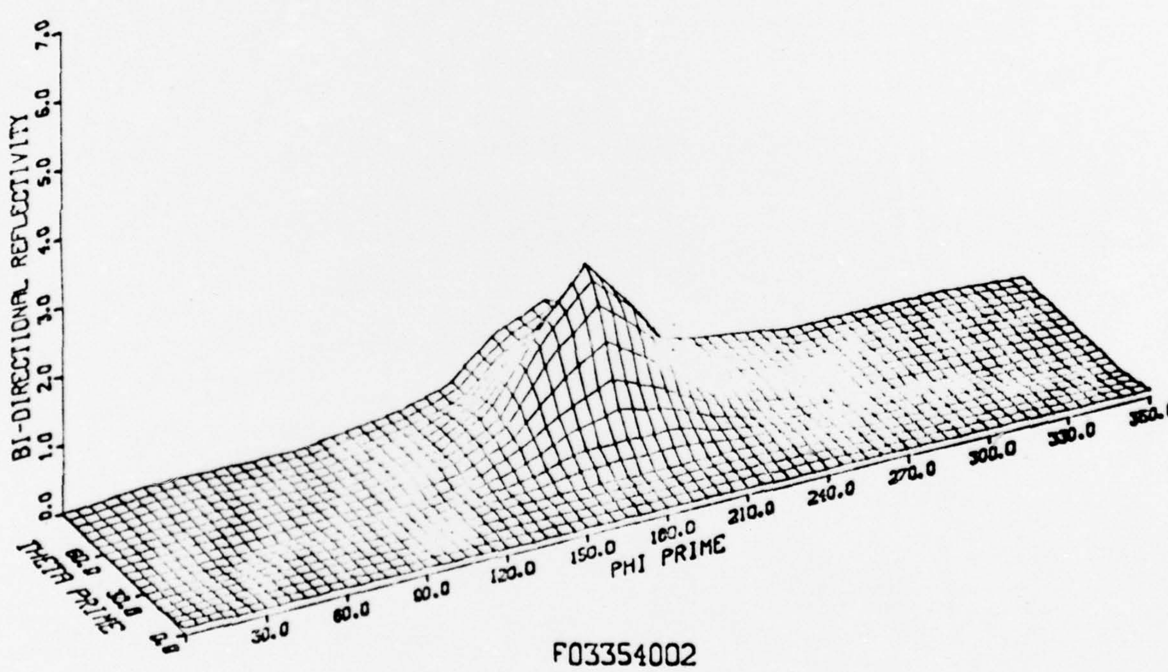

FIGURE IX-48 BIDIRECTIONAL REFLECTANCE

FUSED SILICA GROUND FRONT 30 MICRON GRIT, BACK POLISHED, 0.5 HOURS HF ETCH, ENHANCED SILVER

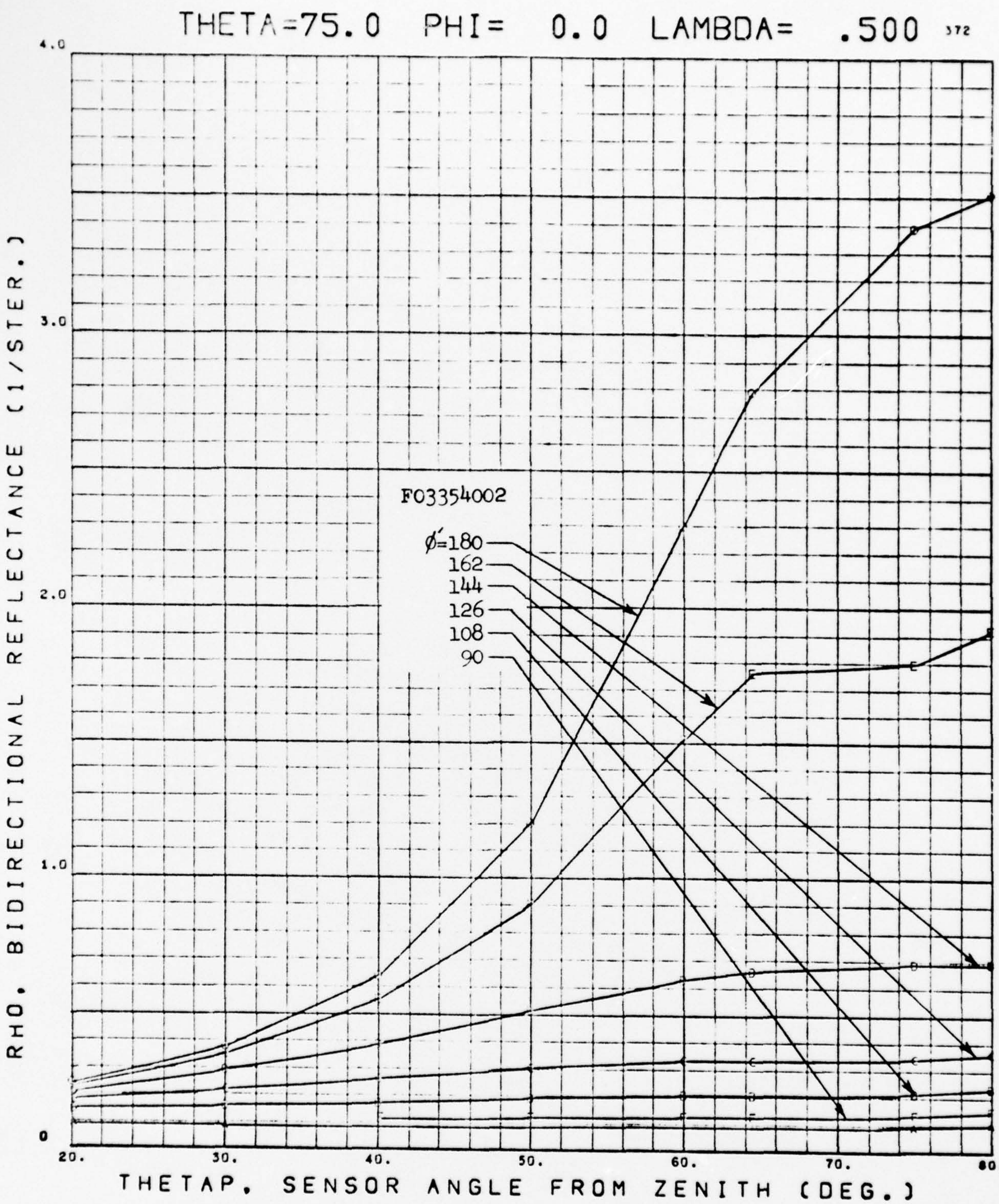

FIGURE IX-49 BIDIRECTIONAL REFLECTANCE

FUSED SILICA GROUND FRONT 30 MICRON
GRIT, BACK POLISHED, 0.5 HOURS HF ETCH, ENHANCED SILVER

.5 MICRONS THETA-75 DEGREES

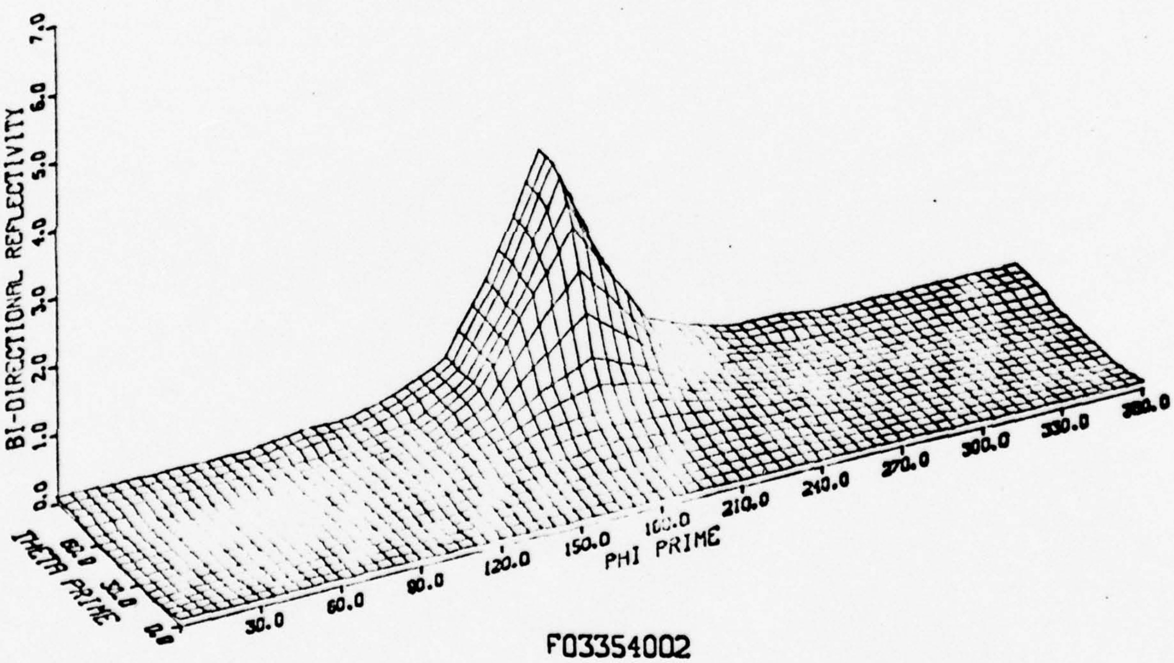

FIGURE IX-50 BIDIRECTIONAL REFLECTANCE

FUSED SILICA GROUND FRONT 30 MICRON
GRIT, BACK POLISHED, 0.5 HOURS HF ETCH, ENHANCED SILVER

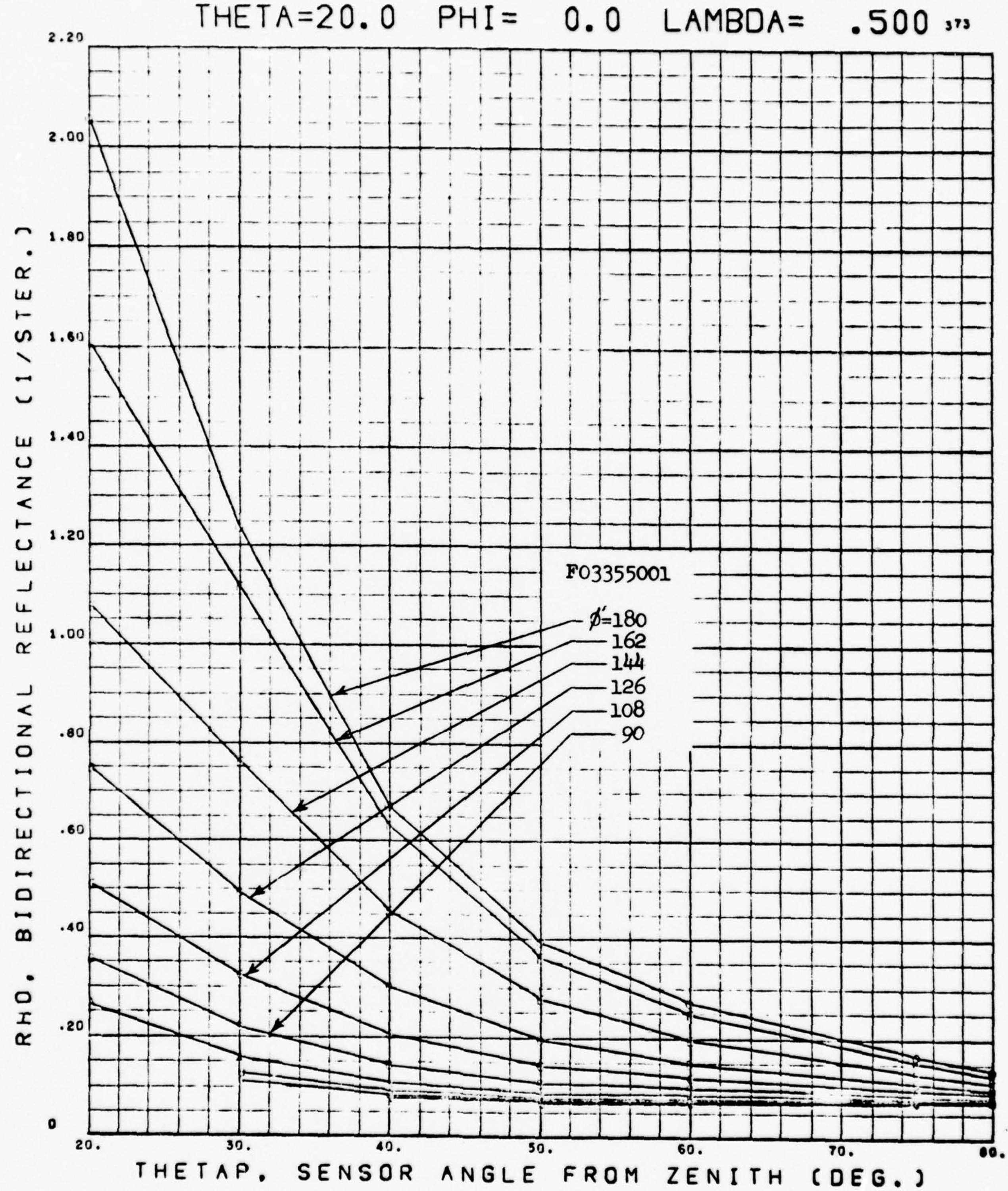

FIGURE IX-51 BIDIRECTIONAL REFLECTANCE

FEP TEFLON PRESSED BETWEEN ROUGHENED FUSED SILICA PLATES. FRONT SURFACE 3 MICRON ROUGHENED SECOND SURFACE 9 MICRON ROUGHENED. BOTH PLATES 0.83 HOURS HF ETCH SECOND SURFACE SILVERED BY SHELDAHL

.5 MICRONS THETA-20 DEGREES

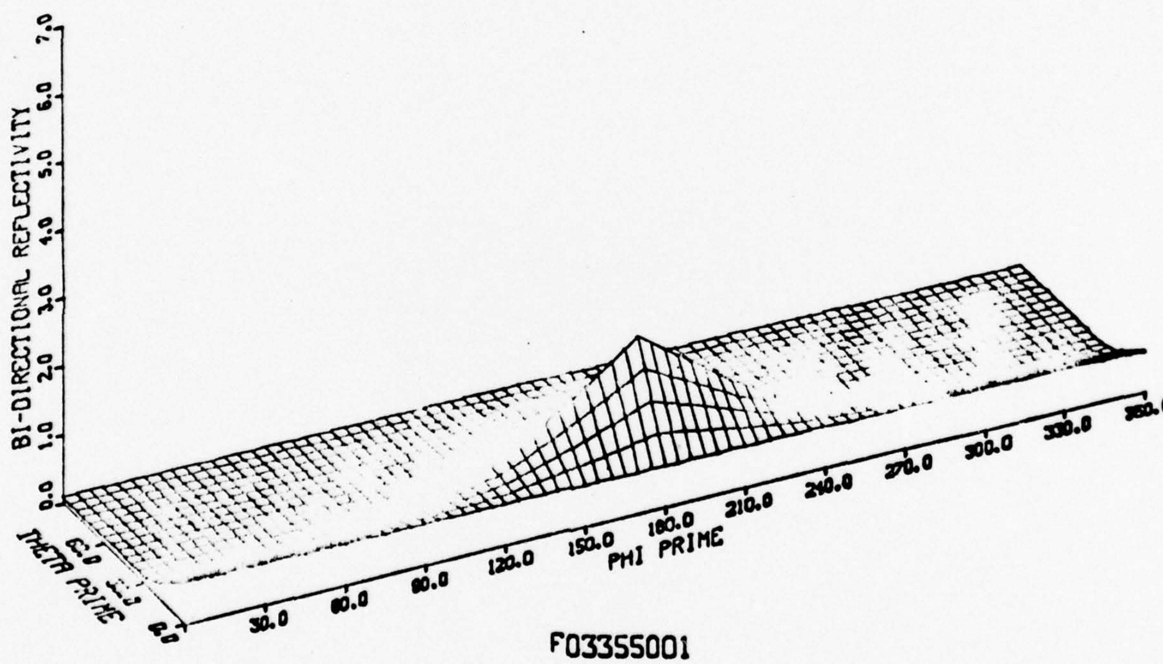

FIGURE IX-52 BIDIRECTIONAL REFLECTANCE

FEP TEFLON PRESSED BETWEEN ROUGHENED FUSED SILICA PLATES. FRONT SURFACE 3 MICRON ROUGHENED SECOND SURFACE 9 MICRON ROUGHENED. BOTH PLATES 0.83 HOURS HF ETCH SECOND SURFACE SILVERED BY SHELDAHL

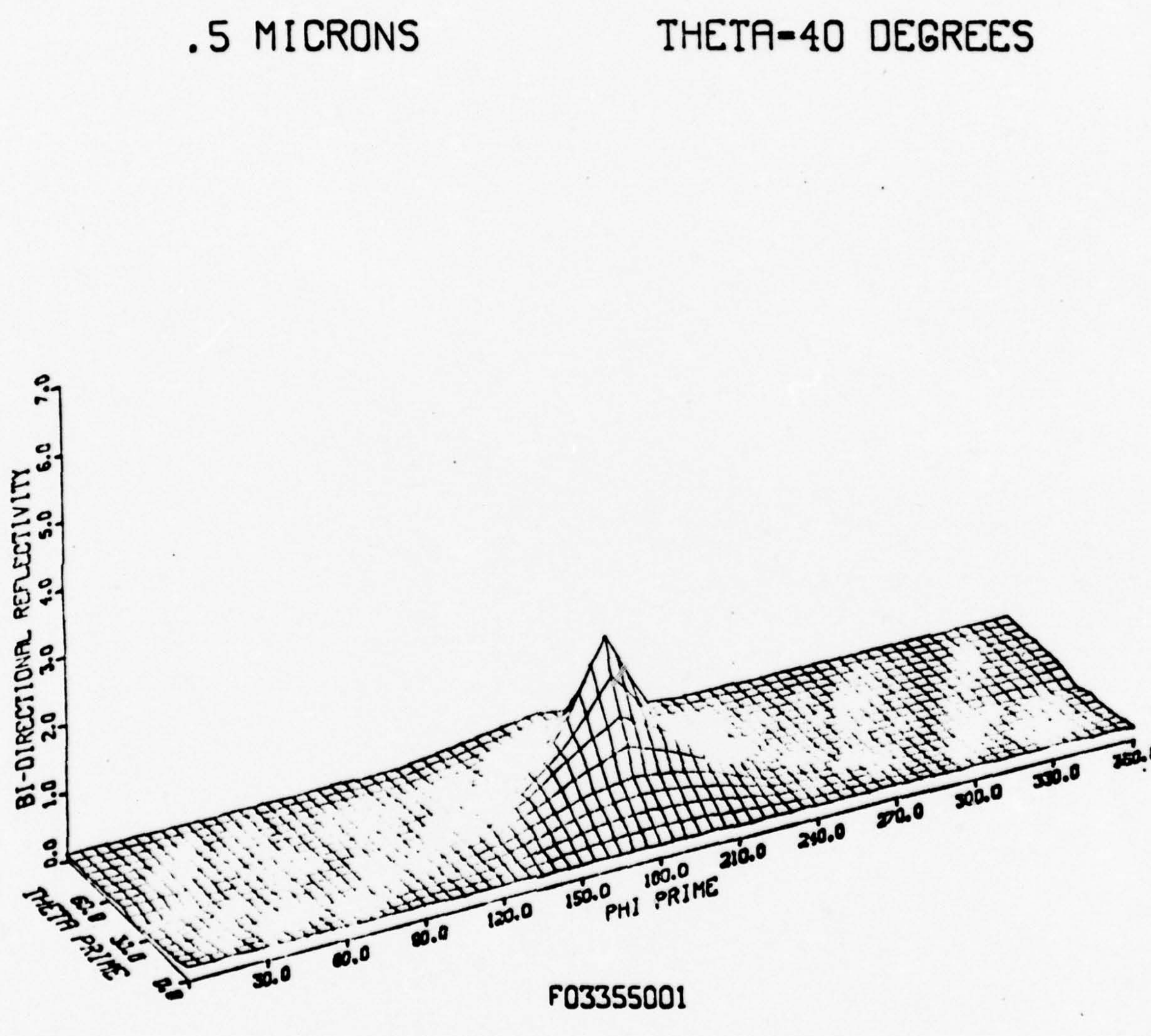

FIGURE IX-53 BIDIRECTIONAL REFLECTANCE

FEP TEFLON PRESSED BETWEEN ROUGHENED FUSED SILICA PLATES. FRONT SURFACE 3 MICRON ROUGHENED SECOND SURFACE 9 MICRON ROUGHENED. BOTH PLATES 0.83 HOURS HF ETCH SECOND SURFACE SILVERED BY SHELDAHL

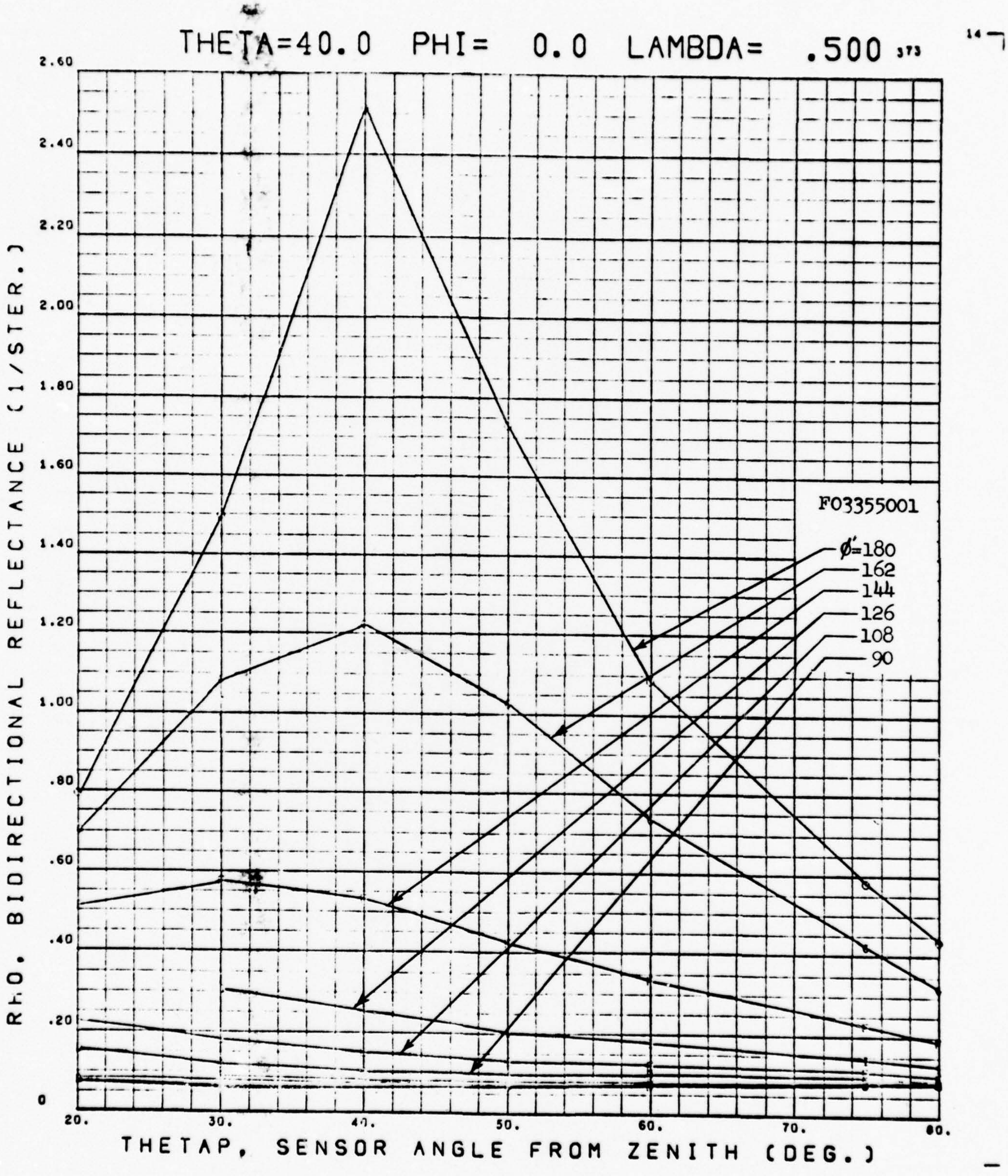

FIGURE IX-54 BIDIRECTIONAL REFLECTANCE

FEP TEFLON PRESSED BETWEEN ROUGHENED FUSED SILICA PLATES. FRONT SURFACE 3 MICRON ROUGHENED SECOND SURFACE 9 MICRON ROUGHENED. BOTH PLATES 0.83 HOURS HF ETCH SECOND SURFACE SILVERED BY SHELDAHL

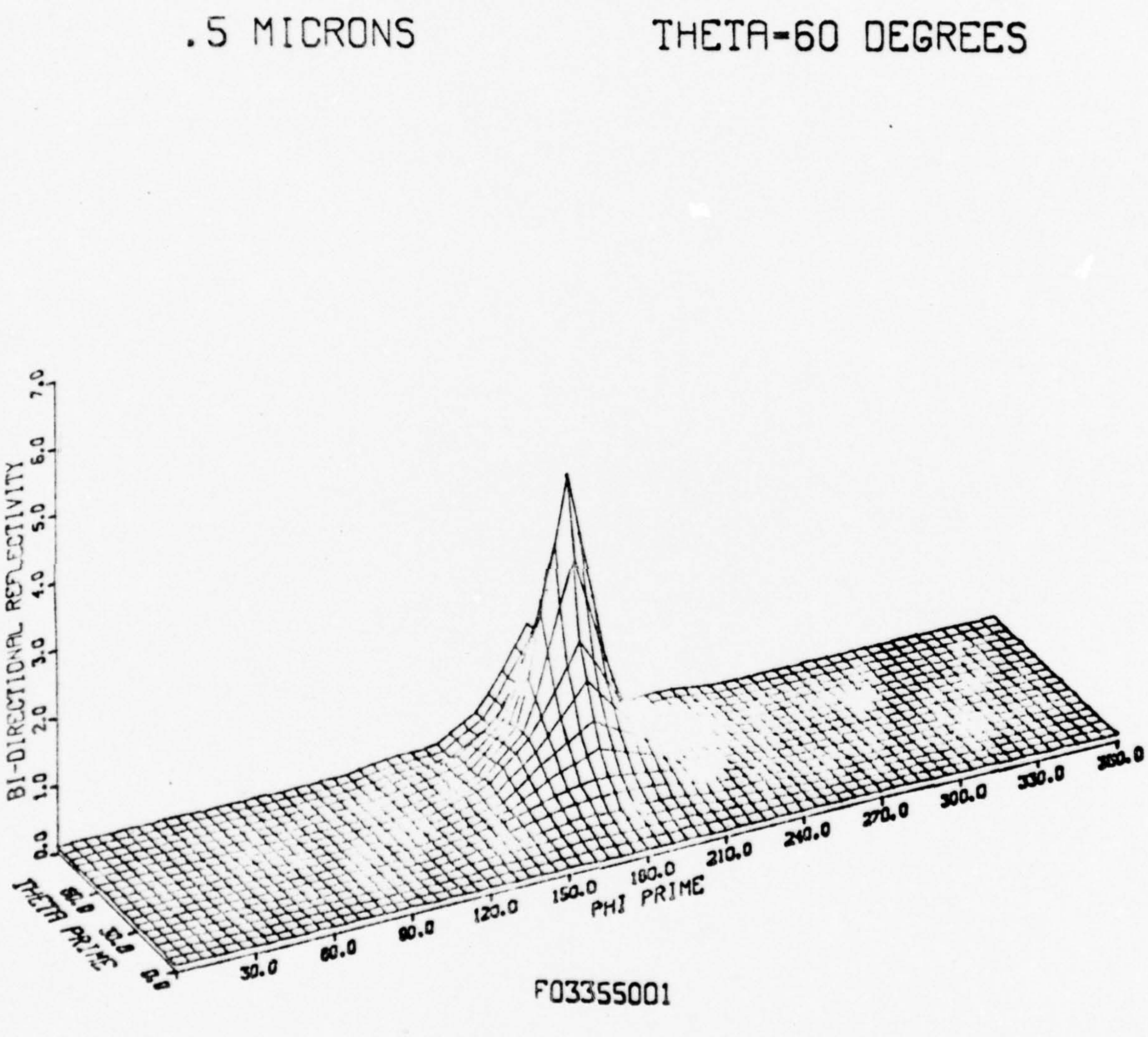

FIGURE IX-55 BIDIRECTIONAL REFLECTANCE

FEP TEFLON PRESSED BETWEEN ROUGHENED FUSED SILICA PLATES. FRONT SURFACE 3 MICRON ROUGHENED SECOND SURFACE 9 MICRON ROUGHENED. BOTH PLATES 0.83 HOURS HF ETCH SECOND SURFACE SILVERED BY SHELDAHL

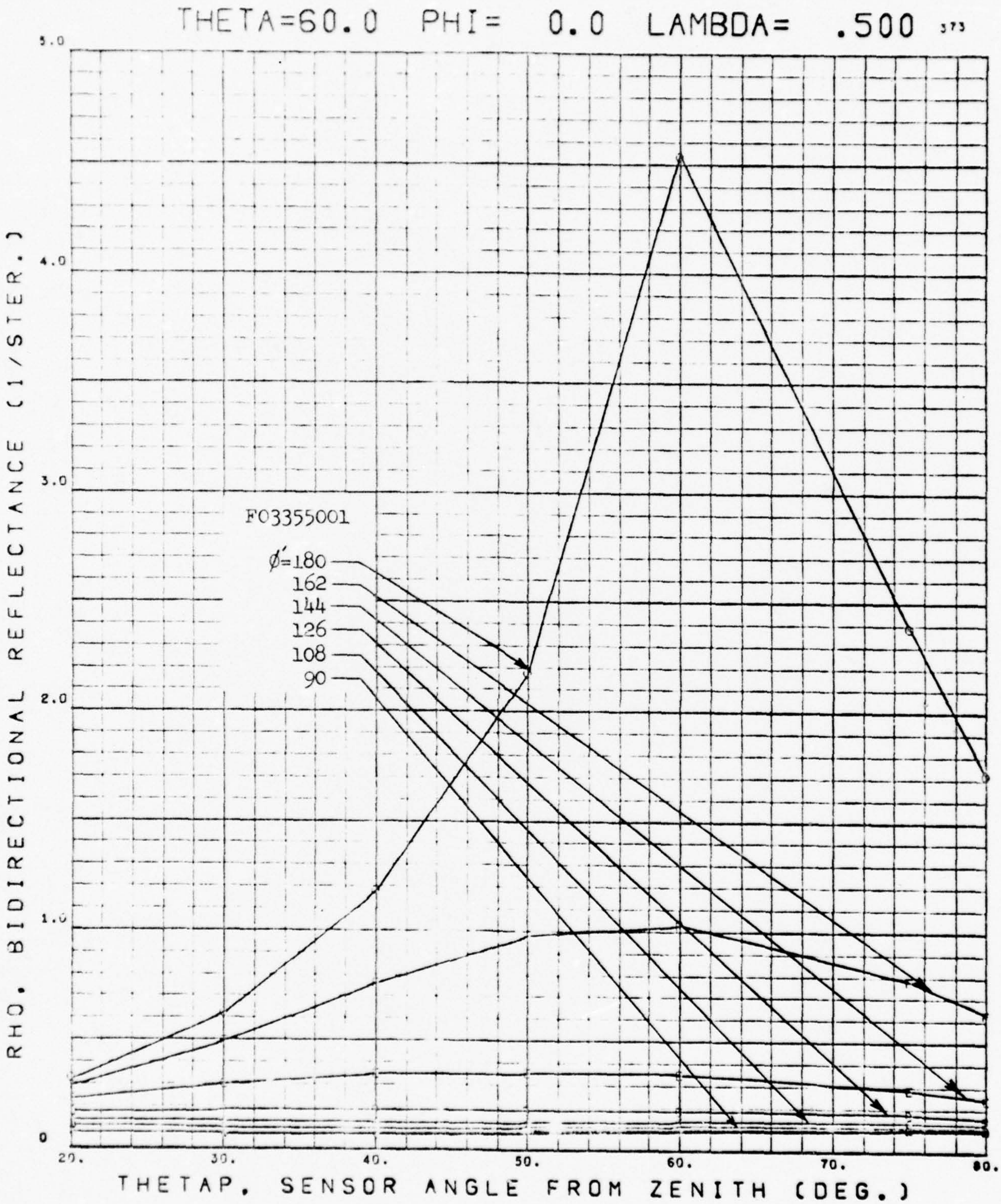

FIGURE IX-56 BIDIRECTIONAL REFLECTANCE

FEP TEFLON PRESSED BETWEEN ROUGHENED FUSED SILICA PLATES. FRONT SURFACE 3 MICRON ROUGHENED SECOND SURFACE 9 MICRON ROUGHENED. BOTH PLATES 0.83 HOURS HF ETCH SECOND SURFACE SILVERED BY SHELDAHL

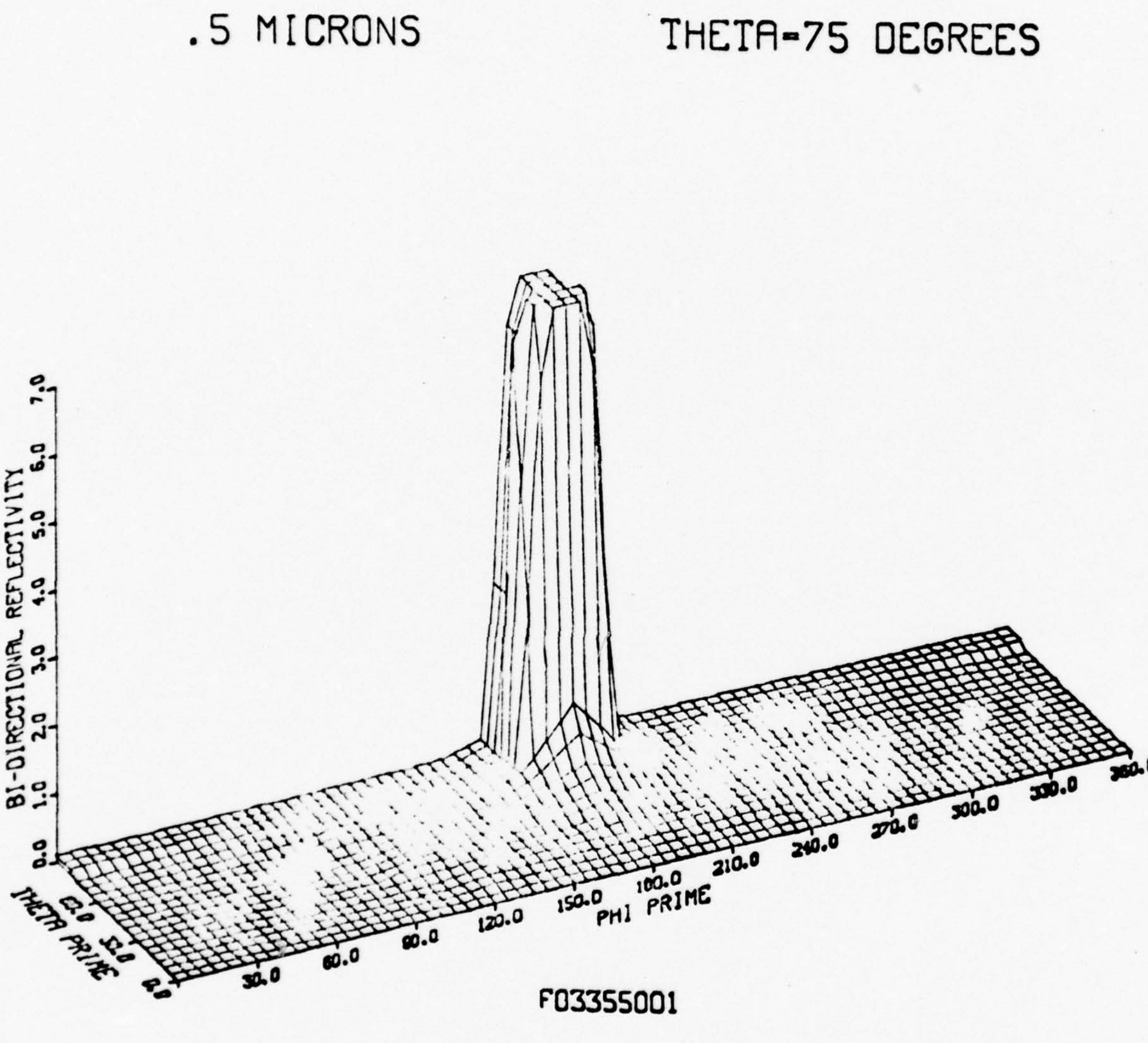

FIGURE IX-57 BIDIRECTIONAL REFLECTANCE

FEP TEFLON PRESSED BETWEEN ROUGHENED FUSED SILICA PLATES. FRONT SURFACE 3 MICRON ROUGHENED SECOND SURFACE 9 MICRON ROUGHENED. BOTH PLATES 0.83 HOURS HF ETCH SECOND SURFACE SILVERED BY SHELDAHL

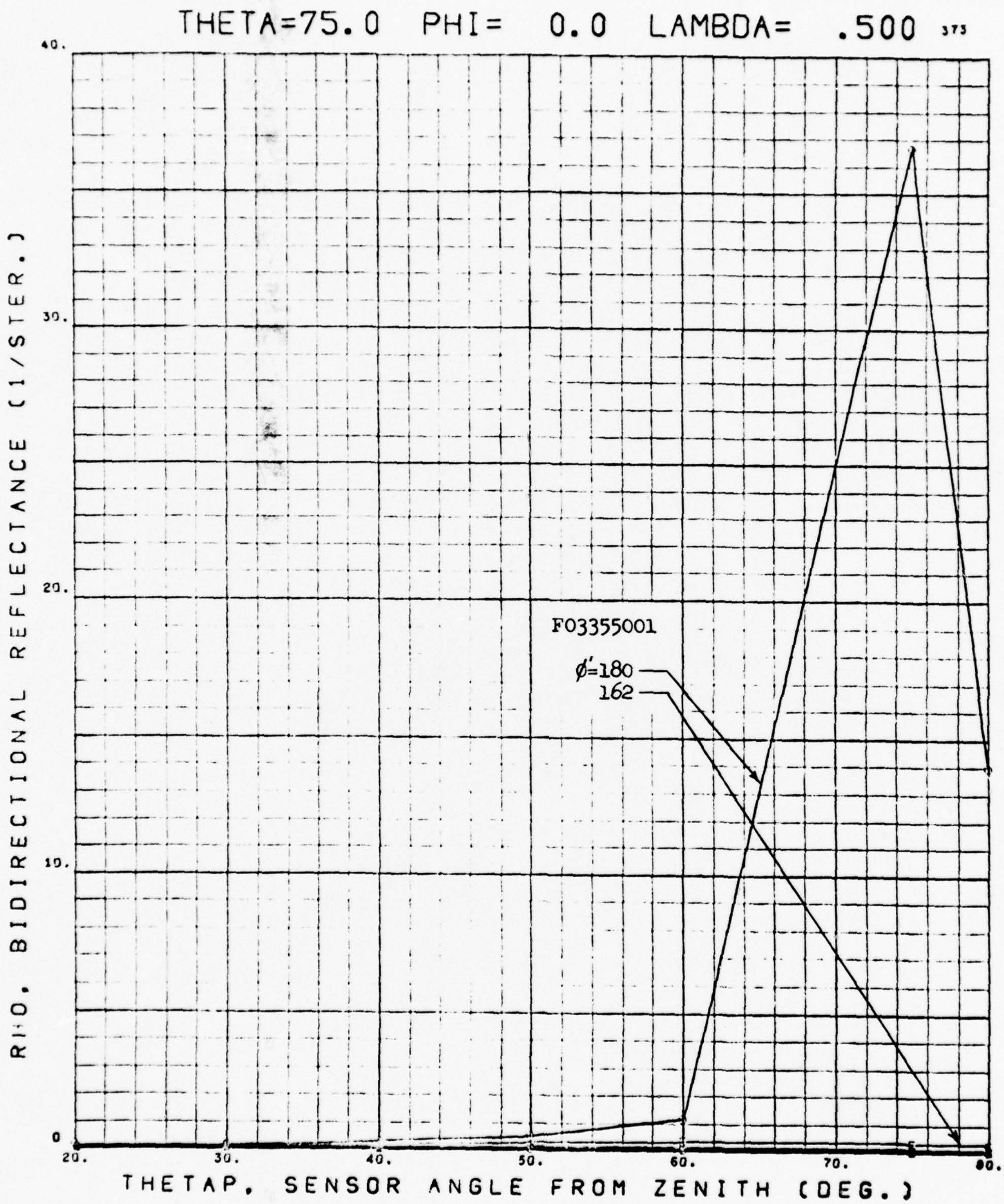

FIGURE IX-58 BIDIRECTIONAL REFLECTANCE

FEP TEFLON PRESSED BETWEEN ROUGHENED FUSED SILICA PLATES. FRONT SURFACE 3 MICRON ROUGHENED SECOND SURFACE 9 MICRON ROUGHENED. BOTH PLATES 0.83 HOURS HF ETCH SECOND SURFACE SILVERED BY SHELDAHL

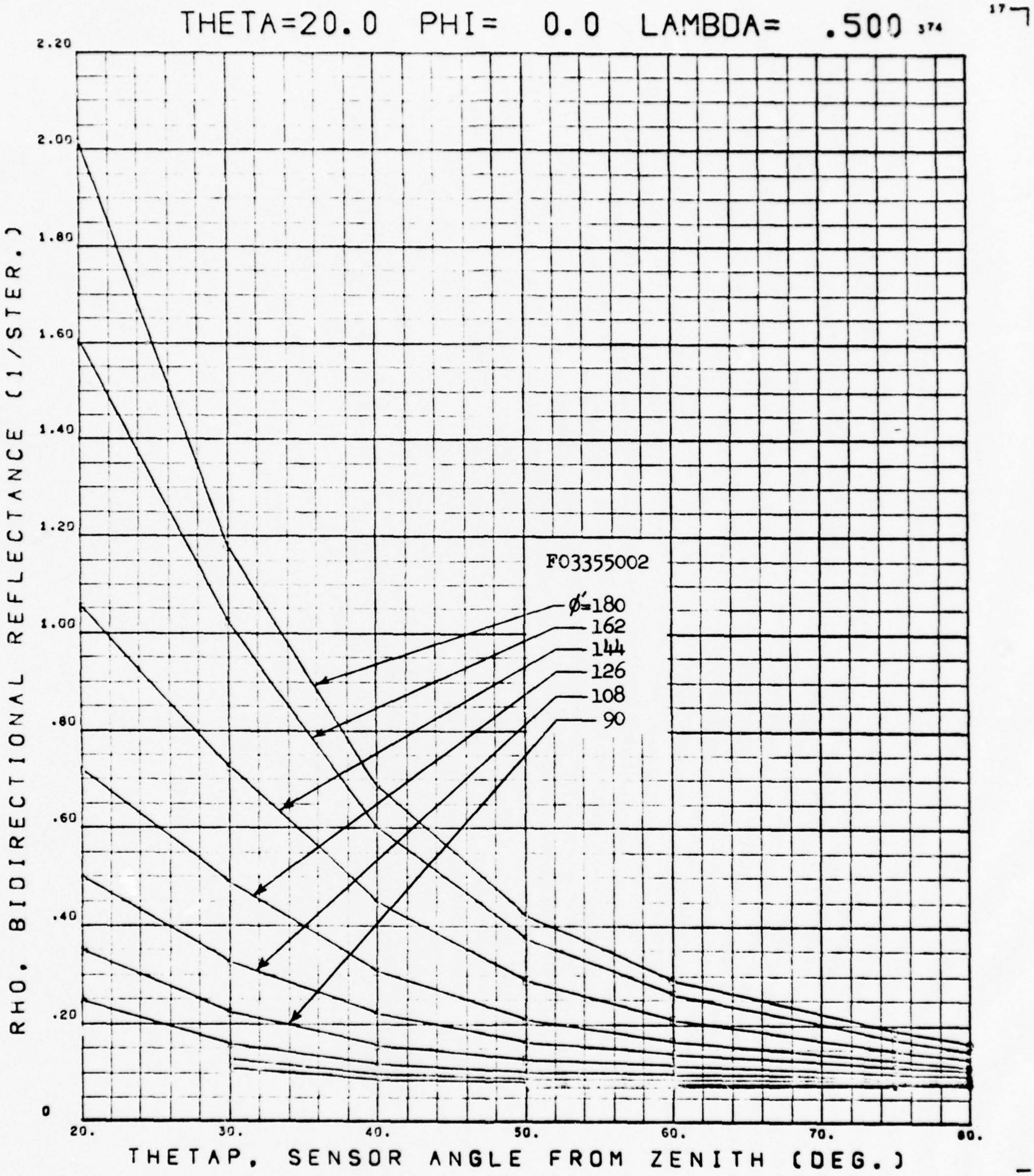

FIGURE IX-59 BIDIRECTIONAL REFLECTANCE

FEP TEFLON PRESSED BETWEEN ROUGHENED FUSED SILICA PLATES. FRONT SURFACE 3 MICRON ROUGHENED SECOND SURFACE 9 MICRON ROUGHENED. BOTH PLATES 0.83 HOURS HF ETCH SECOND SURFACE SILVERED BY SHELDAHL

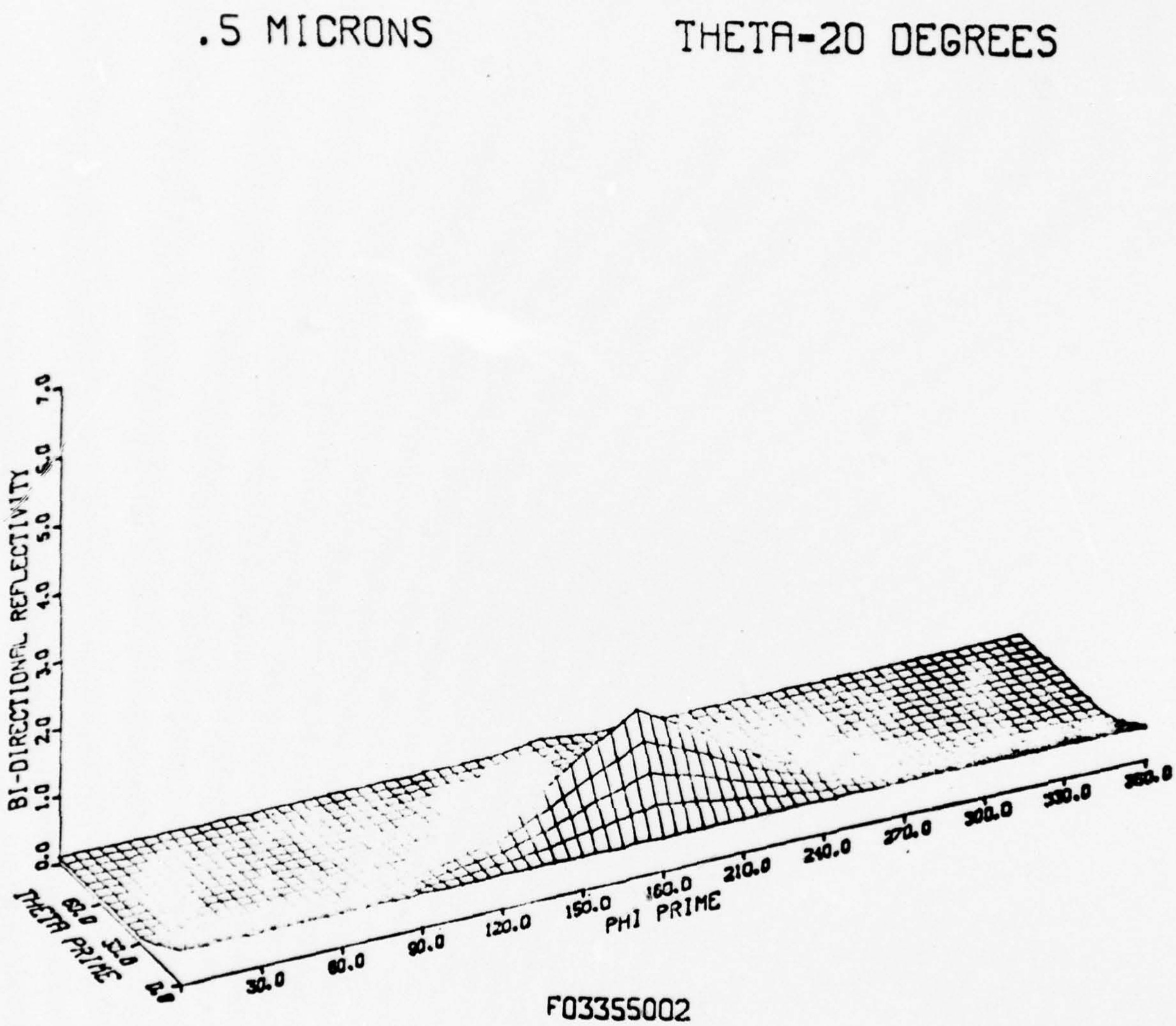

FIGURE IX-60 BIDIRECTIONAL REFLECTANCE

FEP TEFLON PRESSED BETWEEN ROUGHENED FUSED SILICA PLATES. FRONT SURFACE 3 MICRON ROUGHENED SECOND SURFACE 9 MICRON ROUGHENED. BOTH PLATES 0.83 HOURS HF ETCH SECOND SURFACE SILVERED BY SHELDAHL

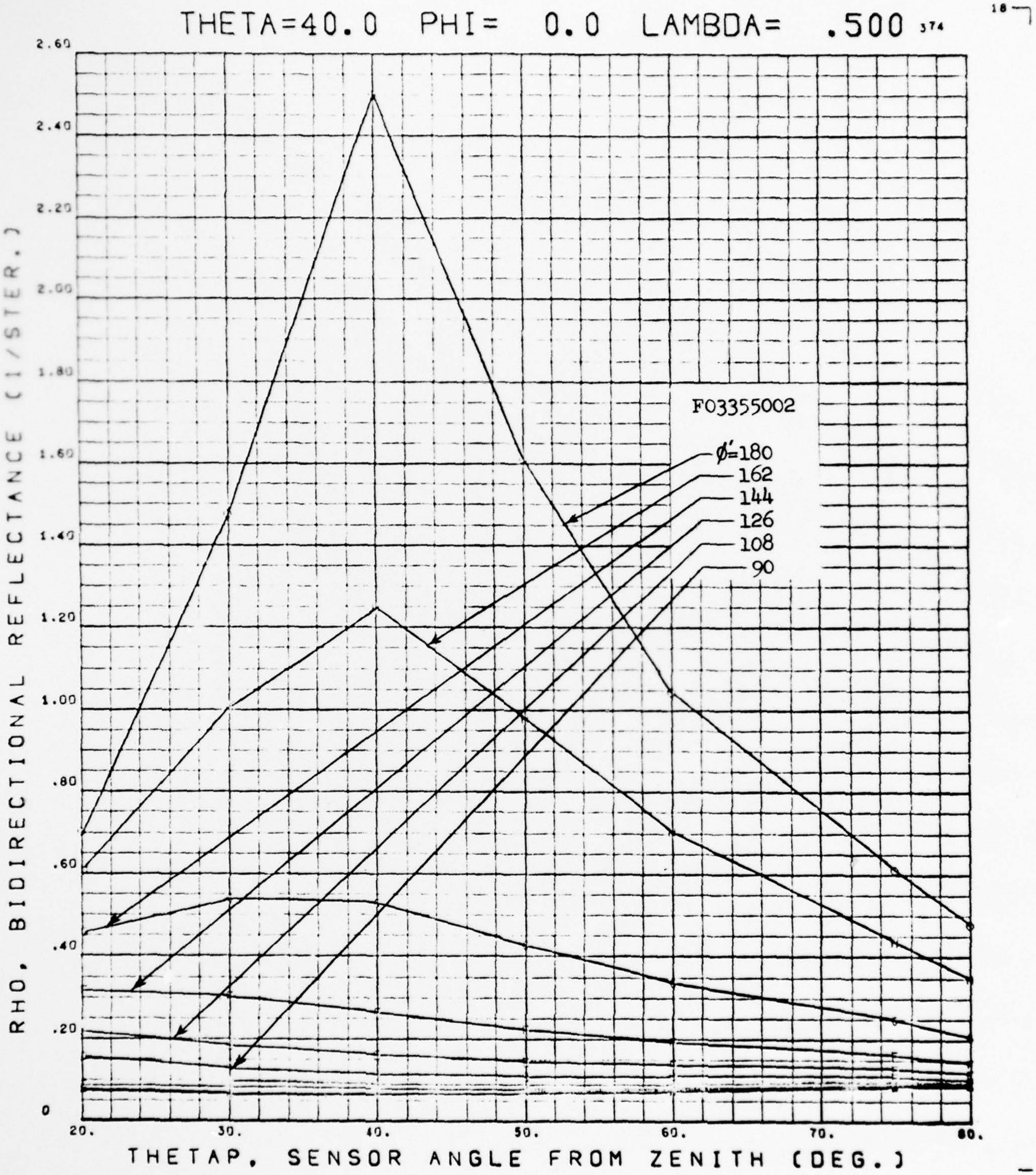

FIGURE IX-61 BIDIRECTIONAL REFLECTANCE

FEP TEFLON PRESSED BETWEEN ROUGHENED FUSED SILICA PLATES. FRONT SURFACE 3 MICRON ROUGHENED SECOND SURFACE 9 MICRON ROUGHENED. BOTH PLATES 0.83 HOURS HF ETCH SECOND SURFACE SILVERED BY SHELDAHL

.5 MICRONS THETA-40 DEGREES

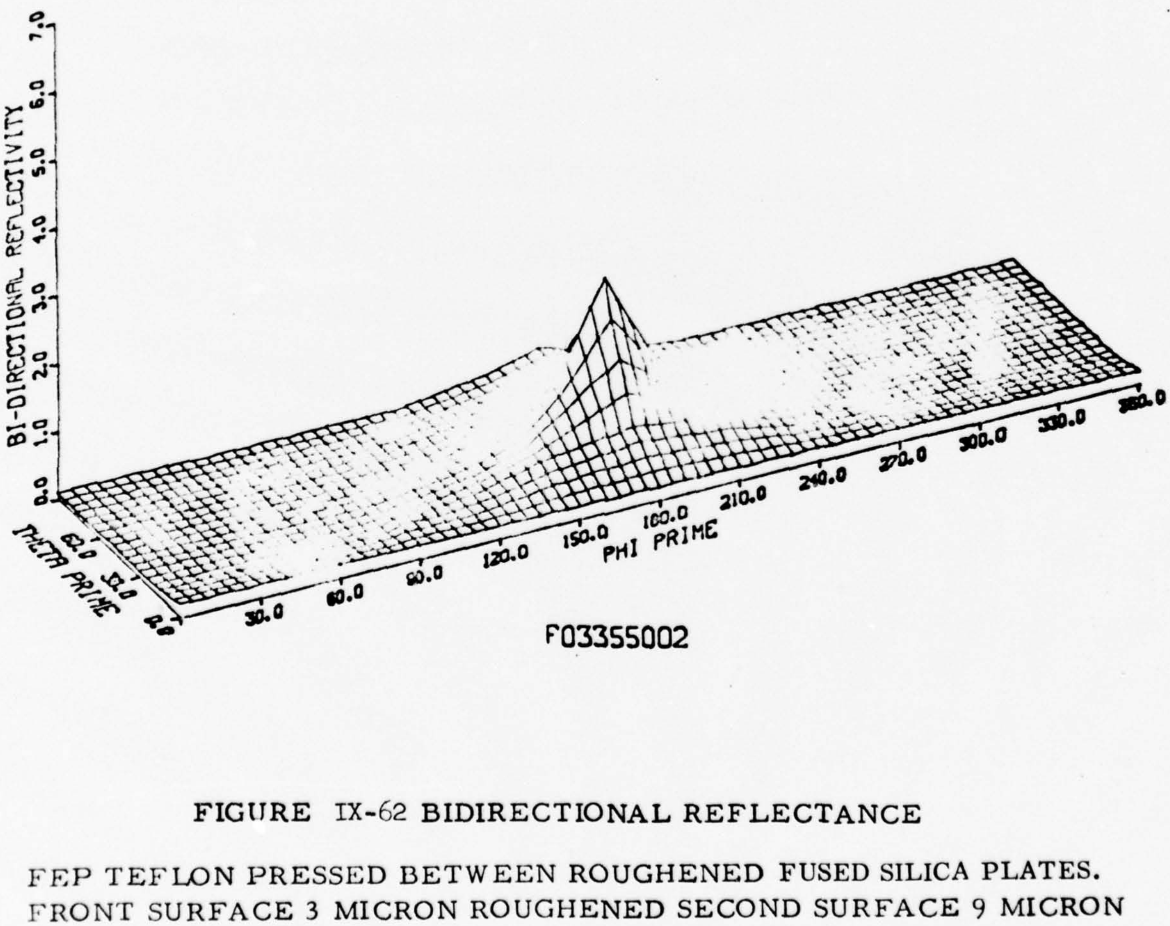

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FIGURE IX-62 BIDIRECTIONAL REFLECTANCE

FEP TEFLON PRESSED BETWEEN ROUGHENED FUSED SILICA PLATES. FRONT SURFACE 3 MICRON ROUGHENED SECOND SURFACE 9 MICRON ROUGHENED. BOTH PLATES 0.83 HOURS HF ETCH SECOND SURFACE SILVERED BY SHELDAHL

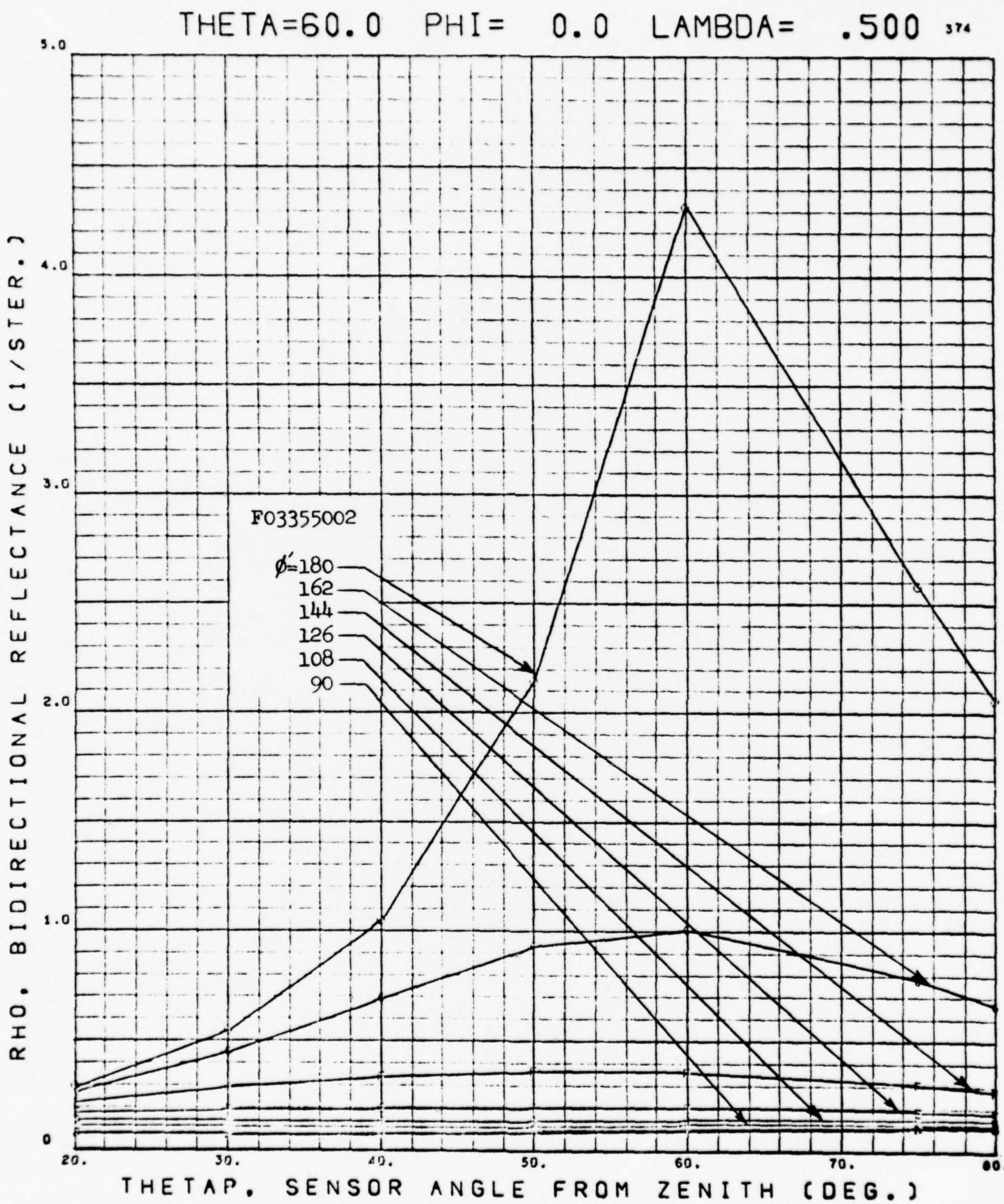


FIGURE IX-63 BIDIRECTIONAL REFLECTANCE

FEP TEFLON PRESSED BETWEEN ROUGHENED FUSED SILICA PLATES. FRONT SURFACE 3 MICRON ROUGHENED SECOND SURFACE 9 MICRON ROUGHENED. BOTH PLATES 0.83 HOURS HF ETCH SECOND SURFACE SILVERED BY SHELDAHL

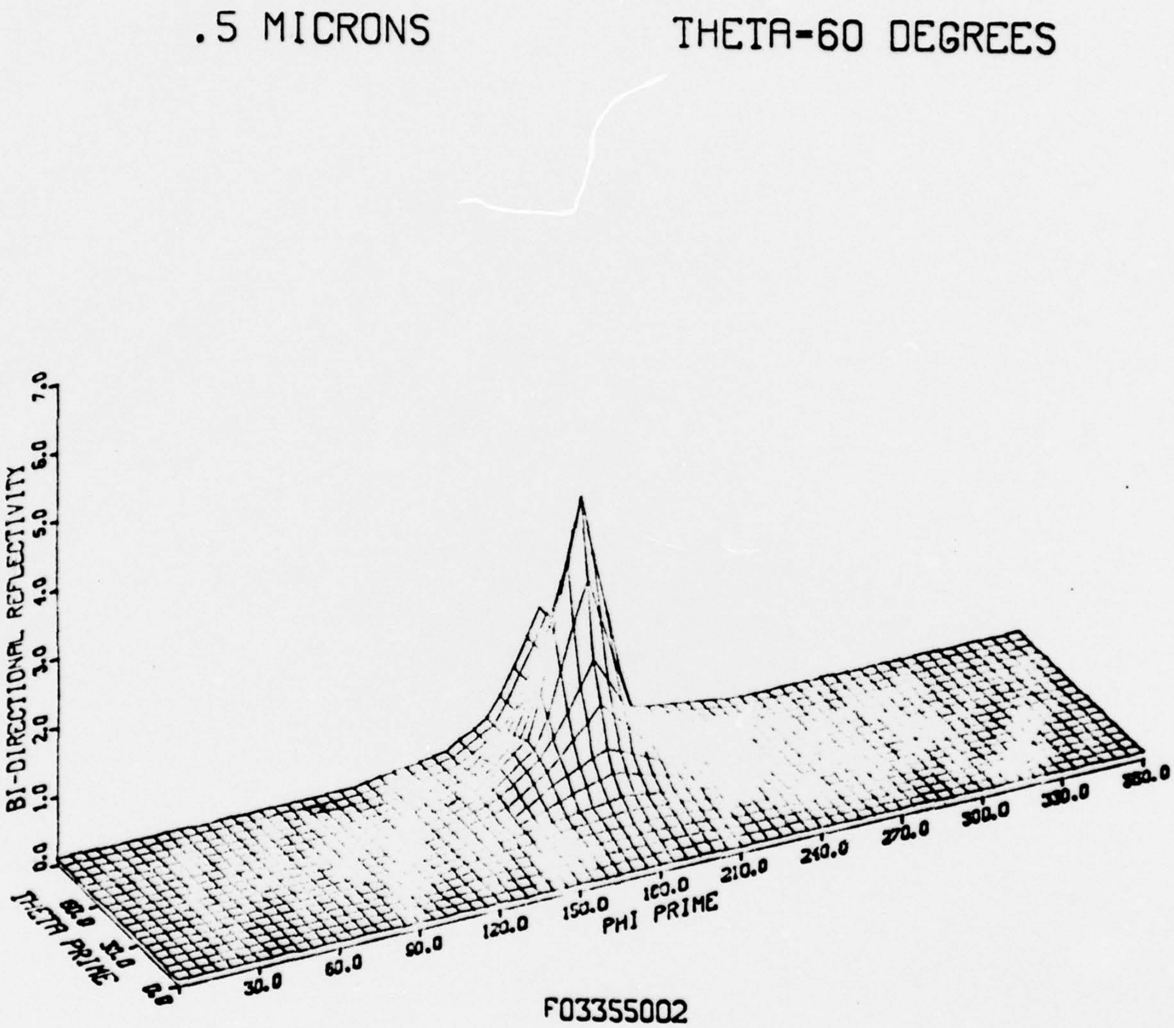


FIGURE IX-64 BIDIRECTIONAL REFLECTANCE

FEP TEFLON PRESSED BETWEEN ROUGHENED FUSED SILICA PLATES. FRONT SURFACE 3 MICRON ROUGHENED SECOND SURFACE 9 MICRON ROUGHENED. BOTH PLATES 0.83 HOURS HF ETCH SECOND SURFACE SILVERED BY SHELDAHL

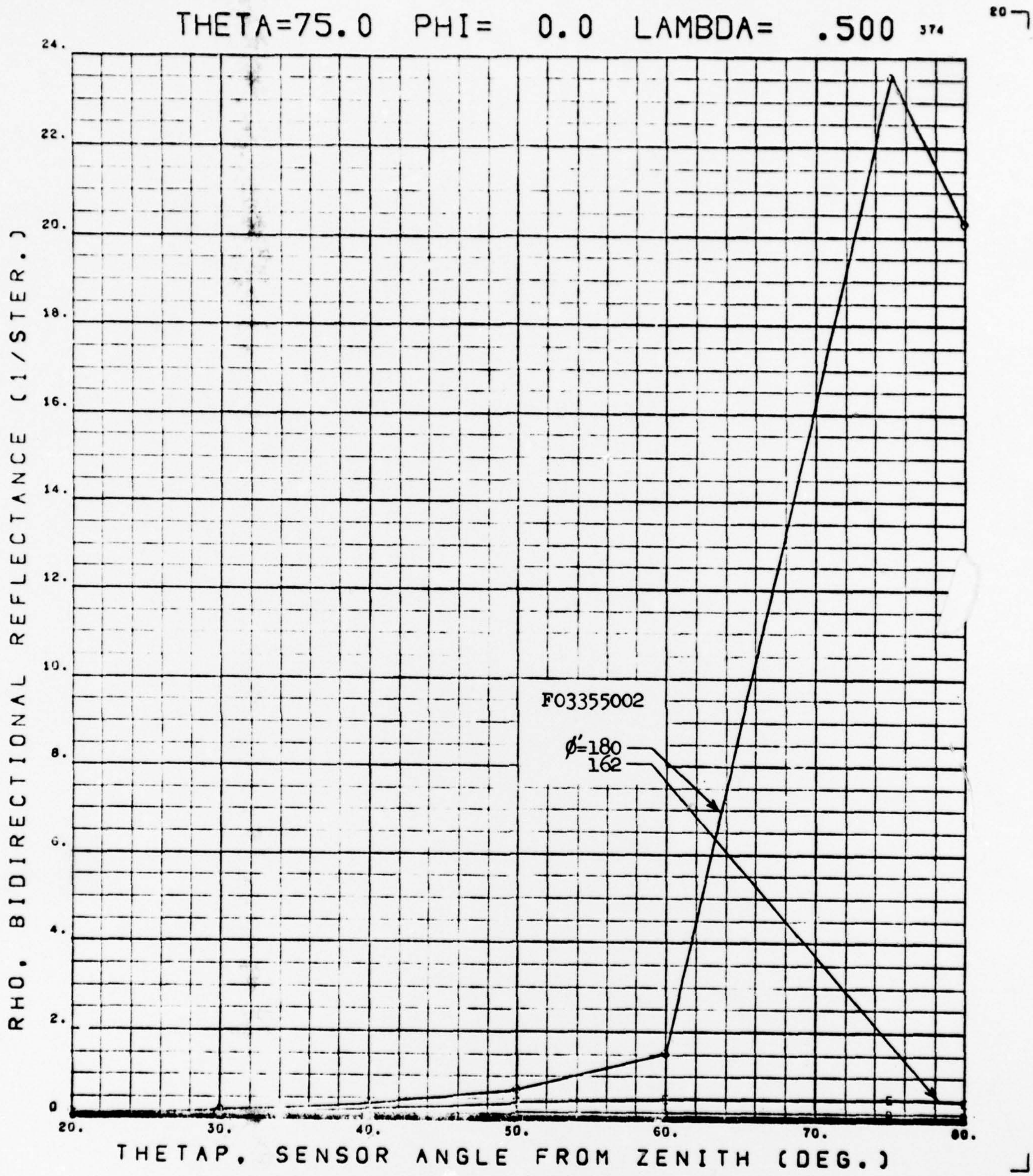


FIGURE IX-65 BIDIRECTIONAL REFLECTANCE

FEP TEFLON PRESSED BETWEEN ROUGHENED FUSED SILICA PLATES. FRONT SURFACE 3 MICRON ROUGHENED SECOND SURFACE 9 MICRON ROUGHENED. BOTH PLATES 0 83 HOURS HF ETCH SECOND SURFACE SILVERED BY SHELDAHL

.5 MICRONS THETA-75 DEGREES

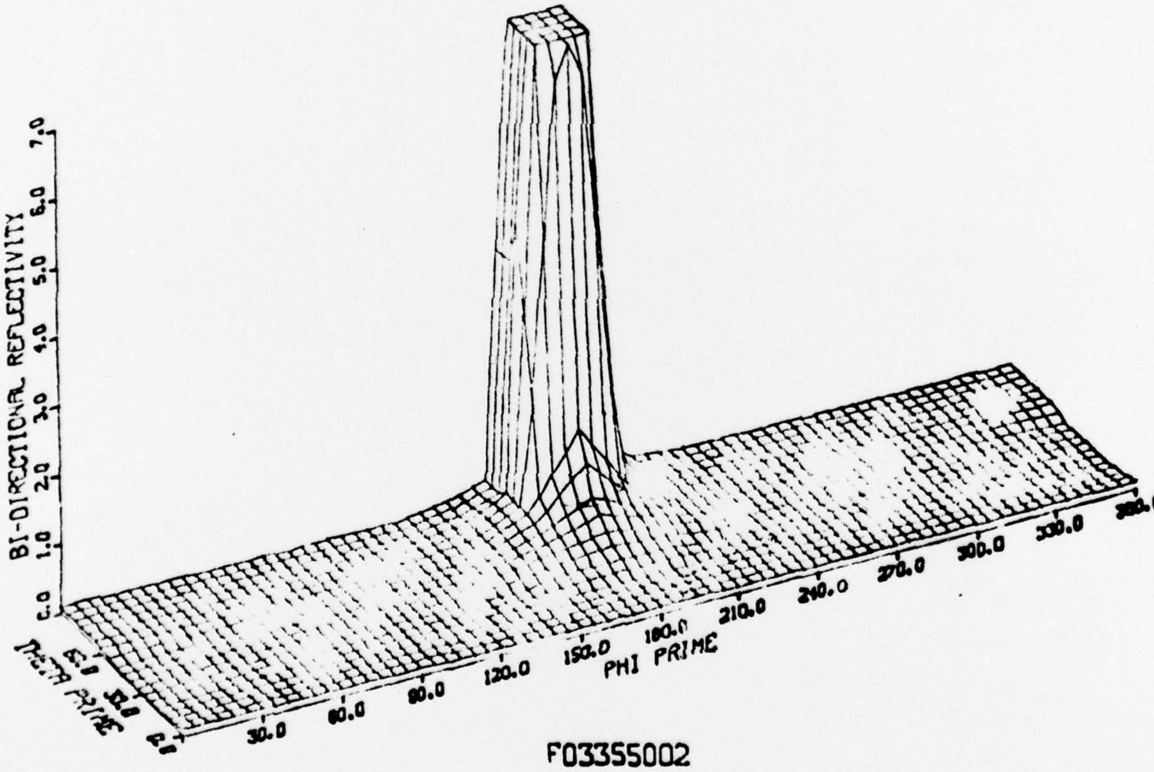


FIGURE IX-66 BIDIRECTIONAL REFLECTANCE

FEP TEFLON PRESSED BETWEEN ROUGHENED FUSED SILICA PLATES. FRONT SURFACE 3 MICRON ROUGHENED SECOND SURFACE 9 MICRON ROUGHENED. *BOTH PLATES 0.83 HOURS HF ETCH SECOND SURFACE* SILVERED BY SHELDAHL

ANNEX X

THEORY AND COMPUTER PROGRAMS FOR SUBSTRATE DESIGN

ANNEX X

THEORY AND COMPUTER PROGRAMS FOR SUBSTRATE DESIGN

For purposes of theoretical prediction of performance, it was assumed that the pattern would have an average or characteristic linear dimension, referred to as a "patterm wave length" (λ_p) and an associated amplitude (Δt_p). Leaving aside for the moment consideration of the actual shape of the contour, some simple considerations constrain λ_p and Δt_p. The pattern must be coarse enough to scatter the light. A λ_p at least twenty times greater than 5000 Å was assumed satisfactory. Acceptable amplitudes are limited by consideration of wafer thickness; pattern waves should not significantly weaken the wafer. It was assumed that an amplitude of up to 5% of the wafer thickness on each side of the wafer (total 10% or 0.001 in.) would be acceptable. Within these constraints, a quite satisfactory contouring was found to be possible.

The two ray-tracing computer programs described below were used to assist in predicting the performance of conceived contours. Program I was relatively simple. It treated only a two-dimensional example of simple regular curves. It was useful to determine the relative performance of surface contours rather than absolute performance. Program II, an extension of Program I, was completely general, capable of treating three-dimensional configurations and thus theoretically suitable to predict absolute performance.

PROGRAM I. This program was applied to second surface mirror designs with a flat back surface and a top surface shaped in two ways: (1) as a sinusoidally varying surface, and (2) as a conchoidal surface. The two-dimensional profiles are shown in Figure X-1. Several computer runs were made to elucidate which of the two profiles was more effective in producing a high-reflectance diffuse surface.

The program traced a set of parallel rays at a given incident angle. The angle of the envelope ($\Delta\beta$ see insert, Figure X-3) of the emergent rays was a measure of the diffuseness. By changing the ratio of the amplitude of the surface variation to its wavelength, the effect of the shape on the diffuseness was determined. The angle of incidence was varied to provide data on scattering performance as a function of angle. The ratio of the pattern wavelength to the pattern amplitude ($\lambda_p/\Delta t_p$) is an important parameter of the surface. A moderate value of this parameter is needed: too large a value would not produce enough scattering of the reflected rays; too small a value will introduce too many internal reflections which lower the reflectance.

The results may be plotted in different ways. Figure X-2 shows the maximum fraction of rays reflected into a fan of one degree, as a function of the ratio $\lambda_p/\Delta t_p$. It is seen that the conchoidal shape gives the better performance: a low percentage of rays contained in one degree at moderately high $\lambda_p/\Delta t_p$. The numbers 0°, 22°, 45° refer to the angle of incidence, α, of the incident rays.

Figure X-3 shows the total scattering angle $\Delta\beta$ of the reflected rays as a function of $\lambda_p/\Delta t_p$. Again the conchoidal surface gives the better results, i.e., larger $\Delta\beta$ at moderate $\lambda_p/\Delta t_p$ values.

Figure X-4 shows the fraction of rays that get internally reflected as a function of $\lambda_p/\Delta t_p$. Once again at moderate $\lambda_p/\Delta t_p$ values, the conchoidal surface is the less detrimental in reducing the reflectance.

This computer program was extended to deal with the profile shown in Figure X-5, i.e., a conchoidal shape with the cusps pointing down. This is important because the surfaces resulting from the process of grinding and subsequent HF etching will have a cross-section, as shown in Figure X-6: the conchoidal profile will have the cusps pointing up in the surface receiving the incident light, and the cusps will be pointing down on the surface which acts as reflector (bottom surface).

As before, the profile used on the computer program is periodic because it is simpler to analyze and prescribe in the computer and it corresponds to the worst case as far as diffuseness is concerned. Any deviation from this periodicity and regularity will improve the diffuseness of the surface.

Surprisingly, the results were practically identical to those obtained with the same profile upside down and described above. Apparently, it is the form of the profile and not its orientation as a whole that is important.

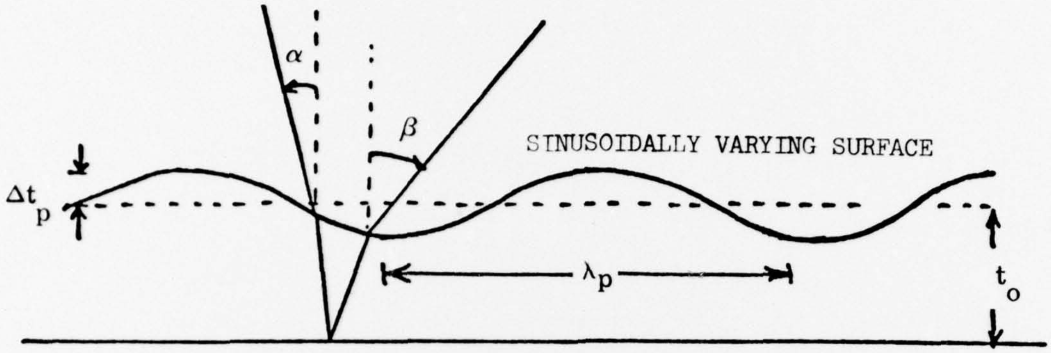
PROGRAM II. Program II is a very general three-dimensional program. It accepts as inputs:

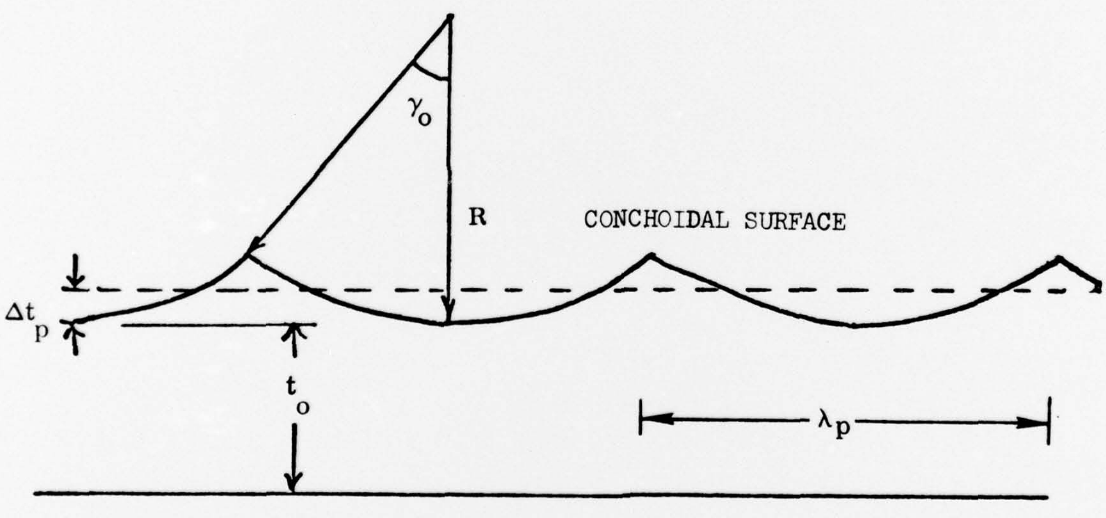
- The mathematical descriptions of the front and back surfaces
- Wafer thickness
- Material properties: index of refraction, reflectance, etc.
- Angle of incidence of the light

The program traces 101 parallel rays incident at the input angle. The first encounter is with the front surface of the wafer where the rays are refracted and enter the mirror material (see Figure X-7 for two-dimensional representation). After refraction at the front surface, the rays travel in a straight line to the back surface. At the back surface they are reflected from the silver second surface and travel to the front surface where they are either refracted and pass out of the wafer, or internally reflected and "recycled" and ultimately emerge or are absorbed in the wafer and do not emerge.

The program output gives:

- Angle of exitance
- Minimum angle of refraction





$$\Delta t_p = R\,(1 - \cos \gamma o)/2$$

$$\lambda_p = 2R \sin \gamma o$$

$$\frac{\lambda}{\Delta t_p} = \frac{2 \sin \gamma o}{1 - \cos \gamma o}$$

Figure X-1. Two Types of Two-Dimensional Profiles, Program I

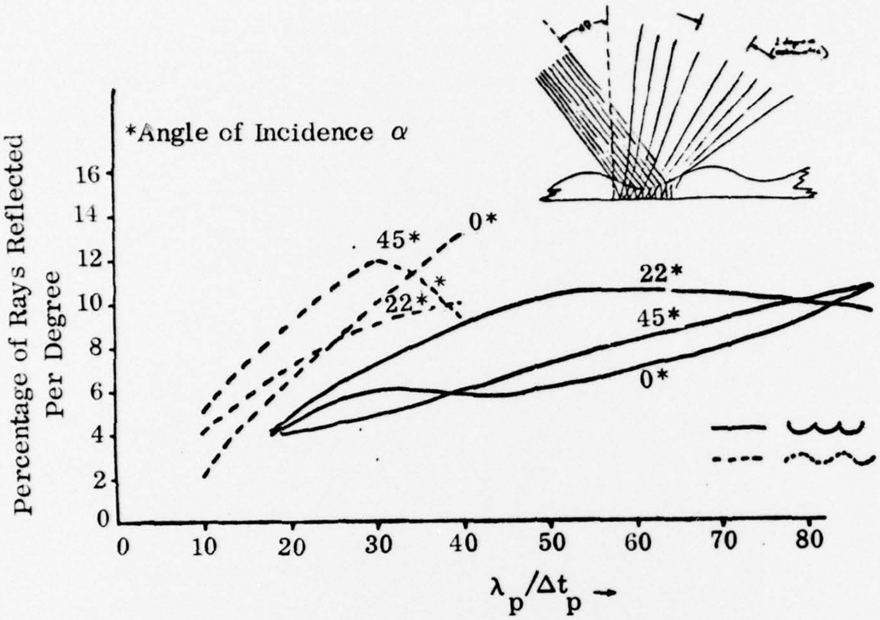


Figure X-2. Maximum Fraction of Rays Reflected Per Degree as a Function of $\lambda p/\Delta t_p$

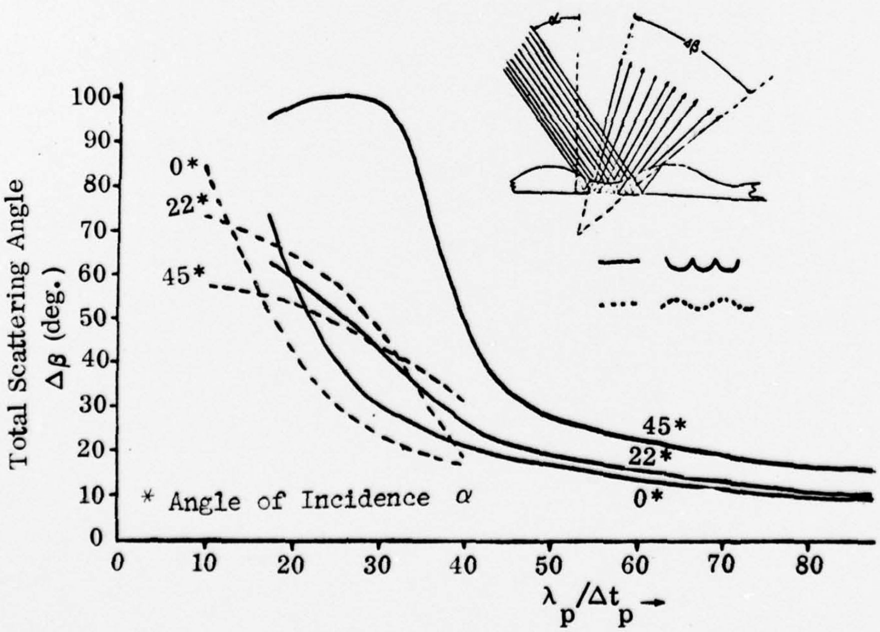


Figure X-3. Angle Into Which Bundle of Parallel Rays are Scattered as a Function of $\lambda_p/\Delta t_p$

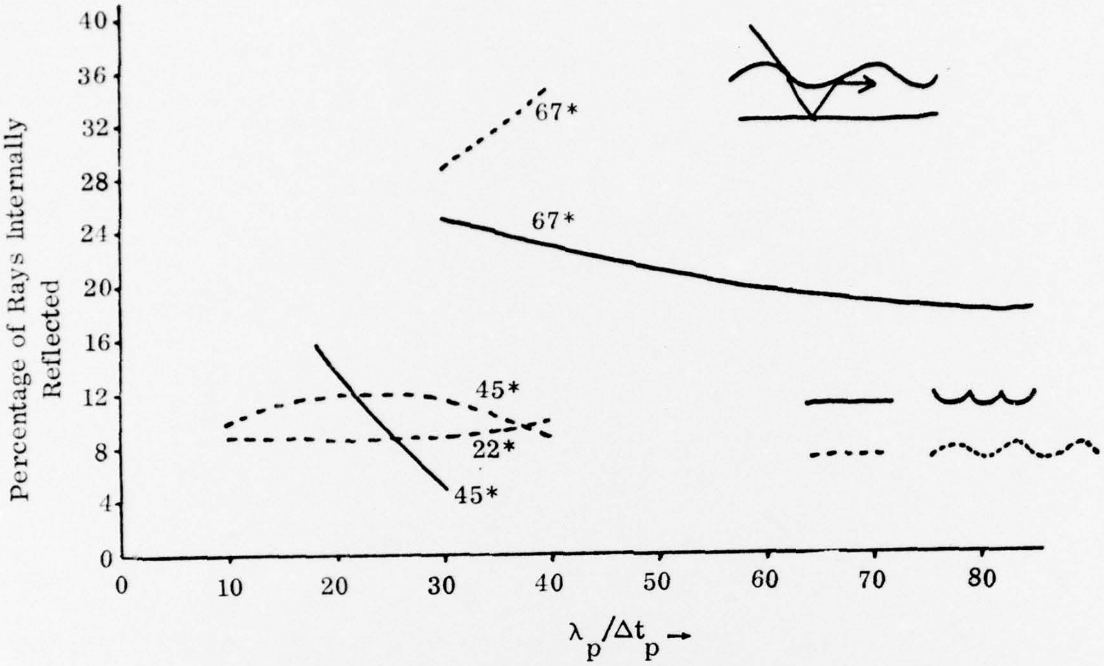


Figure X-4. Fraction of Rays Internally Reflected and Lost

Figure X-5. Second Trial Profile (Conchoidal Shape With Cusps Down)

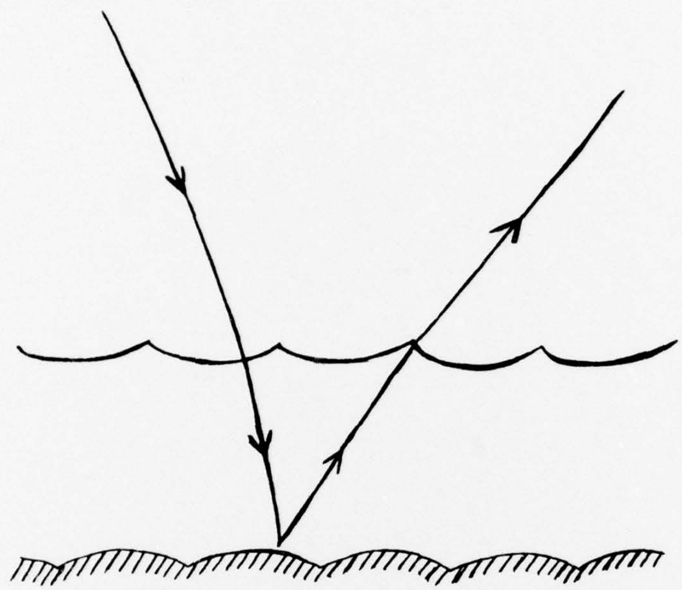


Figure X-6. Profile, Typical Surface Resulting from Etching

- Maximum angle of refraction
- Cone angle of emerging rays
- Number of rays suffering multiple reflection
- Number of rays failing to emerge

This computer program was developed late in this project and it was not fully exploited since the support level was fixed and the priority requirement was a developed mirror, a requirement which was met by concentration on the experimental tasks. It was concluded that this computer program would, however, be a powerful tool for use on similar problems, as for example, the development of a diffuse solar cell. The entire cell could be mathematically modeled.

Five variations of conchoidal surface profiles were arbitrarily drawn, based on the photomicrographs that had been obtained. Then were arbitrarily labeled B, D, E, F, and G and encoded as input data for the program. The results of the runs which were performed are shown in Table X-1.

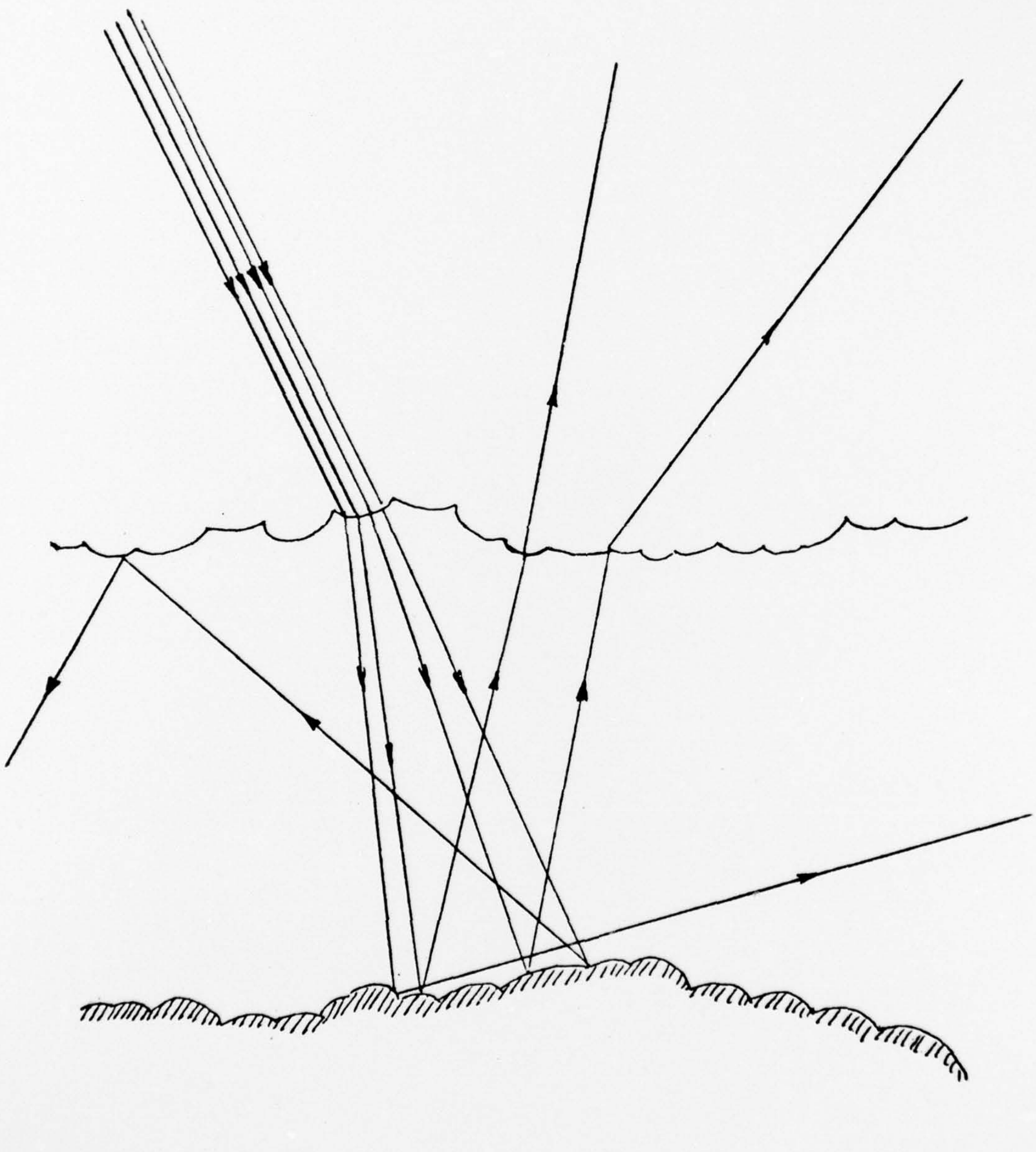


Figure X-7. Ray-Tracing of a Bundle Through a Typical Surface Profile Handled by This Program (II)

Table X-1. Fate of 101 Rays Incident on a Conchoidal Surface

Column heading explanations are as follows:

α = angle of incidence of 101 rays
β = angle of exitance of middle (#50) ray
β_{min} = minimum angle of exitance
β_{max} = maximum angle of exitance
m = no. of rays suffering multiple refractions
ℓ = no. of rays which never exit.
$\Delta\beta$ = angular amplitude of fan of rays
t_o = thickness in mils

"D"* Front Surface "E"* Back Surface

α	β	β_{min}	β_{max}	$\Delta\beta$	t_o	m	ℓ
0	-0.27	-10.39	14.67	25.7	9.5	0	0
30	35.68	18.61	45.51	26.90	9.5	0	0
45	50.59	32.80	63.16	30.36	9.5	0	0
60	79.08	21.56	83.07	61.51	9.5	4	2
30	39.64	17.40	46.49	29.09	18.6	0	0
60	73.12	40.31	86.38	46.07	18.6	2	6
30	25.86	15.20	42.80	27.60	45.8	0	0
60	67.59	22.90	85.71	62.81	45.8	1	6
30	28.96	15.46	47.37	31.92	91.0	0	0
60	71.97	19.68	71.97	52.29	91.0	0	48+

*Variations of surfaces shown in Figure X-7.

Table X-1. Fate of 101 Rays Incident on a Conchoidal Surface (Continued)

"E"*Front Surface "G"* Back Surface

α	β	β_{min}	β_{max}	$\Delta\beta$	t_o	m	ℓ
0	3.37	-13.86	10.95	24.81	9.5	0	0
30	29.2	14.26	43.92	29.66	9.5	0	0
45	48.26	26.15	65.57	39.42	9.5	0	0
60	43.20	38.24	80.13	41.89	9.5	3	4
30	24.82	12.79	45.20	32.41	18.6	0	0
60	63.75	41.38	84.10	42.71	18.6	5	4
30	33.70	12.90	43.54	30.65	45.8	0	0
60	59.24	42.63	78.49	35.86	45.8	0	2
30	37.50	17.00	41.93	24.93	91.0	0	0
60	45.63	41.74	66.74	25.00	91.0	0	38+

"B"* Front Surface "F"* Back Surface

α	β	β_{min}	β_{max}	$\Delta\beta$	t_o	m	ℓ
0	-6.20	-21.49	16.93	38.42	9.5	0	0
30	41.10	9.69	53.05	43.36	9.5	0	0
45	55.06	22.77	74.82	52.04	9.5	0	0
60	77.88	35.44	87.86	52.41	9.5	8	1
30	39.41	8.86	48.21	39.35	18.6	0	0
60	62^{o}.35	40.69	87.44	46.74	18.6	4	2
30	37.09	6.55	51.54	44.99	45.8	0	0
60	47.36	31.06	80.89	49.84	45.8	0	10
30	27.74	7.01	46.59	39.59	91.0	0	0
60	54.29	34.08	75.04	40.96	91.0	0	33+

*Variations of surfaces shown in Figure X-7.

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